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EDUCATIONAL ADMINISTRATION

TWO recent broadsheets by P.E.P. ("Councils and their Schools") have directed attention to the local administration of education and its implications for democracy. The first, which is mainly concerned with the administrative structure of education in Britain, is introduced by the two pertinent questions: "Can provisional standards of efficiency be achieved if real responsibility rests with the ordinary citizen? If not, does the interest of the child demand that the management of its education be surrendered wholly to the expert specialist?"

The 1944 Act provided for an administrative framework in which a harmony of democratic control and technical efficiency could be achieved, and in this broadsheet an account is given of the hierarchy of education authorities, of the composition and functions of local education committees and of schemes of divisional administration in county areas. The second broadsheet discusses educational administration on the level of the individual school, as well as parent–teacher associations and other voluntary organisations connected with the schools.

In examining the machinery of local educational administration, the writers of the first broadsheet have brought together, in a form not otherwise readily accessible, information about the size and populations of the local education authorities and divisional executive areas as well as methods of co-opting members on to education committees. As they rightly point out, assessment of the merits and defects of the 1944 Act can only be tentative, because several of its main provisions have not yet been implemented and many bodies have only recently been constituted.

Some general principles of educational administration have been clearly defined by the Act. The relation between the central Ministry of Education and the local education authorities has been significantly altered. Instead of being merely advisory, the Ministry of Education is now more an executive agency possessing the right to make final decisions on many of the administrative schemes and policies of the local education authorities. This change in the Ministry's function has been unusually prominent during three years of acute shortage of man-power and materials necessitating direct control of available materials from the centre, and many local education authorities are finding it increasingly difficult to distinguish the new permanent statutory functions of the central department from its recently acquired temporary functions. Although these are due to the pressure of special circumstances, local education authorities are feeling the limitation of their sovereignty more acutely than they might otherwise have done, and tend to forget that there is considerable scope for local initiative. The most important elements of educational policy, for example, are the conduct and curricula of schools, and these are still subject to local decisions. Moreover, no significant intermediate regional agencies have been developed, and contact with the Ministry is still direct. His

Majesty's inspectors possess no executive functions except that they may approve certain items of expenditure.

Under the 1944 Act, the Ministry and the local education authorities are thus clearly defined as the chief levels of administration. The Act also provides for a considerable degree of decentralization. In county areas divisional executives have been established, while in all areas managers and governors have to be appointed for individual schools or for groups of schools. This, at least, is the theoretical division between the different levels of administration. In practice the division is less clearly defined, and the place of the divisional executive has proved to be one of the less happy developments of the 1944 Act. Divisional executives were created as a compromise between those who believed that education administration should be vested solely in the county and county boroughs, and those who thought the larger non-county boroughs and urban districts should become local education authorities in their own right. Neither faction has been satisfied. Schemes of divisional administration exist in only thirty-eight counties, and in twenty-one of these there are only one or two divisional executives. Most of the divisional executives set up under county schemes are *ad hoc* bodies and often do not sufficiently represent a community of interests to interpret local views effectively. Yet, the broadsheet concludes, "in spite of all the problems and inconsistencies found within the system, it appears that the chief purpose of the divisional schemes—the participation of a larger number of people, and the expression of local interests, in educational administration—is being achieved. The new method is costly and generally rather slow, for the delegation of functions involves the use of more officers, together with delays in passing on reports and in waiting for decisions from one committee to another on the different tiers of administration."

While this cautious optimism might be justified in some cases, many divisional education officers are feeling acutely frustrated and, as their president, Alderman C. Barton, M.P., said to the recent annual conference: "While there is this apparent tendency towards a broader interpretation of the powers of divisional executives, it is true to say that the restrictive effect of over-elaborate regulations, highly centralized control of supplies, and quite minor details of administration all tend to weaken the real effectiveness of delegated powers. In many cases, too, the stringency of financial control exercised by the county council reduced the delegation to a mere farce."

Nor is discontent confined to the divisional education officers themselves. Before the introduction of divisional executives, some further education establishments in county boroughs were under the control of the county education authority. Now they come under the dual control of both the county authority and the divisional executives, and heads and principals of these establishments are placed in a dilemma as to the proper arbiter of their problems. In certain matters the head is instructed to refer to the divisional executive; in others to the county authorities; on occasion to both.

After three years experience of divisional executives there is a growing body of opinion that they have no executive place in educational administration and that they should be abolished in favour of a second tier of local administration. This should be made up of those people in intimate touch with the schools, the governors and managers. Selected governors and managers could form local educational advisory committees served by a staff whose duty it would be to keep in touch with schools, teachers, parents, managers and governors.

It is with the composition of governing and managing bodies of schools and the link between parents and teachers that the second broadsheet is chiefly concerned. Starting with the assumption that most people have some real interest in schools and should possess some method of making their influence felt, the broadsheet reviews the means whereby the various interests and experience of different kinds of people could be brought within the administrative system. Besides the establishment of divisional executives, the 1944 Act provides for co-option to education committees and, for every school maintained by a local education authority, a body of governors for secondary and managers for primary schools. These bodies have been only slowly established, and the problem of finding people to serve on them has frequently been the cause of delay. The 1944 Act provides for the grouping of schools, and, usually from expediency, this provision has been widely used. Like most expedient solutions the grouping has proved to be widely unpopular, particularly with those head teachers who are trying to build up local pride and interest in their schools.

Most appointing bodies are trying to discharge their responsibilities conscientiously; but they have been seriously criticized for doing too many jobs themselves instead of bringing new people into local administration. Their reply that new people cannot be found is more a commentary on the narrowness of the contacts of local representatives than of the shortage of public-spirited citizens. "Councillors do not always look beyond the members of their political party and their circle of friends."

The Ministry of Education has issued model articles of government which have been generally used by local education authorities in preparing their schemes for government and management. A division of responsibility is suggested in which "the L.E.A. would have the right to settle the general educational character of the school and its place in the local system. Subject to this general responsibility the governors would have general direction of the conduct and curriculum of the school. The headmaster or headmistress would control the internal organisation, management and discipline of the school, and would also have the power of suspending pupils, subject to a report being made forthwith to the governors and the L.E.A." This provides a *modus vivendi* between the local education authority and the governors and managers. Where there is no system of divisional administration these school bodies are the only local

agents of the education authority. "Wherever there is a three-tier system of administration, competition and conflicts between the different levels are more likely to arise. On each step of the hierarchy there is a latent and sometimes active conflict between those which are immediately above and below each other. The local education authorities have very much the same attitude towards the Ministry of Education as the divisional executives have towards the local education authorities."

It is difficult for divisional executives to take an objective and positive attitude towards governors and managers, because they themselves are agents of decentralized and detailed administration. The boundary between their field of activity and that of the school boards is often blurred, some of the functions assigned to them belonging in principle to governors and managers as well.

It is also easy to forget that the object of educational administration is the individual school and the effect it has on the children in the schoolroom and the playground. The interpreters of educational ideals are the teachers in the schools, and their relationship with governors and managers is the most difficult and subtle problem of all. Primarily this is a relationship which has to be worked out amicably with head teachers; but "in a democratic system it is important that assistant teachers should feel that there is someone who, in matters of discipline and promotion as well as in the day-to-day routine of the school, is there to hold the balance and to see that justice is and appears to be done".

The authority of governors and managers must be wisely and tactfully used and rests on the fact that the head and his staff are the servants of the community; the authority of the school board is a sanction against abuse of power and neglect of duty.

At the school the most vitally concerned representatives of the community are parents. Yet they are the least organised, and their official place within the educational system is that of bystanders rather than of active participants. It is rare for them to sit on committees or act as governors or managers, because they are mothers and fathers and for no other reason. It is only through parent or parent–teacher associations that they can nominate representatives and make representations to governors or managers. Their more active participation in local education administration will depend on whether parent associations intend and are able to take part in the running of the nation's schools. The aims and associations of these parent or parent–teacher associations are very varied, and they seem to grow more freely in schools which serve a socially homogeneous area than in others; they exist most frequently in artisan and middle-class neighbourhoods and are found more often in nursery and secondary schools than in primary. Examples of the work of parent–teacher associations show that they can be a powerful instrument of educational progress. Their effectiveness can be considerably increased if the basis of association were communal rather than sectional; parent–teacher groups which take an active interest in all the broader aspects of education are the exception rather than the rule. There might be much more concern to form such groups if the reward of representation on education committees and similar bodies were offered to them. Examination of local administration suggests that too narrow a field is harvested in the choice of people to serve on education committees and local school bodies. The belief among councillors that the verdict of voters at a council election should be the only passport to participation in local government should give way to the conviction that education should have a wider appeal than that of ordinary local government and politics. Many parents would be glad to serve on government and managing bodies and local education committees if given the chance. Local education administrators should possess the will and the wit to bring them in. In so doing they would do well to remember the prudent rule of the London County Council, that no parent may become a manager while he has a child in the school concerned; parents with children who have left school may be the people to nominate.

TEN YEARS PROGRESS IN HORTICULTURAL SCIENCE

Hormones and Horticulture

The Use of Special Chemicals in the Control of Plant Growth. By George S. Avery, Jr., and Elizabeth Bindloss Johnson, with the collaboration of Prof. Ruth M. Addoms and Prof. Betty F. Thomson. (McGraw-Hill Publications in the Botanical Sciences.) Pp. xi+326. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 27*s*.

TWELVE years ago Avery and Burkholder, with other collaborators, translated "Die Wuchstofftheorie" (Boysen-Jensen) and published a very useful introductory account of "Growth Hormones in Plants" which reviewed the literature concerned with the discovery and isolation of highly active substances from plant tissues, and with the application of these substances and chemically prepared compounds to plants. The ensuing interval has witnessed a rapid and wide extension of the list of synthetic compounds of very high activity, and has also afforded some, but perhaps not as yet sufficient, time in which to estimate the value of their practical application on a commercial scale to cultivated plants. The present volume deals with this expansion and the more practical applications, as the sub-title indicates.

The preface contains the remark that, "a chemical revolution is sweeping through the agricultural world"—others may think it is seeping through some parts of the world—and that, "by the application of minute amounts of growth controlling hormones we enter an important new era". Whether or not such bold claims be true, there can be no doubt that the diversity of the uses to which these substances can be put affords great interest to chemist, botanist, horticulturist and practical growers of many crops. To cater for such diverse readers the text has been prepared on broad general lines, without undue technicality.

The term 'hormone' is used in the widest possible sense, to permit, for example, the inclusion of a discussion of the use of dinitro-cresylic acid to thin out fruit blossoms, and the application of ethylene chlorohydrin to terminate dormancy (here reverting to the classical derivation of the term). Somewhat surprisingly, a chapter is included on the use of colchicine in the production of polyploid varieties.

A tabular presentation of the results of many experiments, made with a fairly wide range of chemical substances on many plants in an endeavour to facilitate plant propagation by acceleration of rooting from cuttings, is a valuable feature; it occupies a quarter of the whole text and is even then far from complete. A further list of unresponsive plants is provided; but the discussion of the results from the point of view of the later growth of the stimulated cuttings is perhaps not sufficiently critical. The statement that the use of such compounds is now standard practice does not generally apply to Great Britain.

The extensive tests made in America on the control of the pre-harvest fall of apples, by means of both sprays and aerosols, are well reviewed; as yet the difference in response shown by varieties remains to be fully explained; but in wind-swept districts this treatment has proved of high value, especially overseas. Another chapter is concerned with the stimulation of the ovary by chemical means and the subsequent seedless development of the fruits, a subject of current interest at research stations in Great Britain, where the process of parthenocarpy is being analysed into distinct phases. As this example shows, it is well-nigh impossible for any text to be quite up to date in such a subject. Again, a valuable table shows the range of plants that have responded to the applied chemicals. The authors have very rightly taken up a more critical attitude when reviewing the application of such compounds to seeds in attempts to stimulate early growth; these have been generally unsuccessful. As elsewhere in the book, there are helpful illustrations showing the injury that high concentrations may cause to plant tissues, and lists of the plants that have been damaged by selective weed-killers are given.

Prominent specialists have co-operated with the authors by supervising the preparation of the reviews of their own particular subjects, so that the text has an authoritative air; each chapter concludes with a general evaluation of the methods reviewed, although there is a slight tendency towards a favourable verdict discernible in the judgments. The chapters are briefly summarized, and selected references are freely provided. Author and subject indexes are also provided. The format maintains the well-known high standard of presentation associated with the publishers.

In such a rapidly developing subject, plant physiologists, after reading this book, are left to work out their own theories, and to discard their older ones; chemists will make new substances of yet greater activity, and no doubt together these workers will evolve new theories to explain the relationship between chemical structure and physiological activity. The horticulturist must try repeated tests with more varieties of his plants; no one can yet predict the reaction of related species in regard to weed-killers. But all these workers, together with a body of present-day and future students, will be grateful for this review of a decade's progress in applied science.

M. A. H. TINCKER

GOODNESS DEFINED

The Definition of Good

By Dr. A. C. Ewing. Pp. vii+215. (London: Routledge and Kegan Paul, Ltd.; New York: The Macmillan Company, 1947.) 12*s*. 6*d*. net.

FROM age to age, men have contemplated the problem of good; not infrequently, however, they have found themselves discussing what *things* are good, an entirely different question. Dr. A. C. Ewing is quite clear; his concern is with the former. This being so, he sets out to offer stout resistance to subjectivism and to naturalism in ethics. Why exactly does he do this? Because these tenets erode, as it were, any rational basis, and therefore render the superstructure of moral obligation insecure. The approach is positive and impressive—criticism, counter-criticism and the development of an appropriate alternative. The author modestly (and no doubt rightly) declines to put pressure upon "people to do what they know to be their duty"; unluckily, however, the number of readers of this book cannot be expected to be very great, and outside them must be a multitude by whom guidance—perhaps even direction—would willingly be accepted. In a word, we need an interpreter, somebody like Thoré, who in his day demonstrated to the uninitiated the power and majesty of the Barbizon painters; for, power and majesty these pages possess, but they are not easy reading.

An example occurs quite early (p. 4) in dealing with the advance of scepticism in ethics. The author fastens upon the belief that, in the minds of many, ethics are bound up with religion. This may well be so; but few would deliberately maintain that these activities are identical, or that the failure to hold to the one necessarily—or even probably—invalidates the other. As Dr. Anderson Scott once put it, they "interlock", a phrase which at once suggests that they can well be separated. And separable they must be, if both are to fructify.

Again, the axiological dilemma—a matter of taste rather than of objective truth—admits of no answer beyond that expressed with exceptional beauty and humility by the late Prof. A. E. Taylor (1926), that we shall never find what we are not sincerely looking for, and very likely value almost at zero. The instrument is there, but the will to use it is not.

Ethics thus emerges as a study *sui generis*, incapable of reduction or derivation to or from any other subject. In an illuminating chapter, concepts like good, right, obligation, are said to be capable of being related to some non-ethical forms, without the possibility of identity with any combination of such. Nevertheless, on the next page, the proof of the pudding ['s goodness] is [still] in the eating, implication and all.

'Good' is then subjected to analysis in terms of 'ought', using Moore's expression "worth having for its own sake", and the pro attitudes of Ross. 'Fittingness' becomes the king-pin of ethics rather than moral obligation. The author gives three excellent reasons for this choice, the strongest—it seems to me—being that belief that the proposed act is fitting is a necessary (and sufficient ?) state of mind to be in before any moral obligation can be willingly accepted. Inversion is easily seen to make nonsense.

One cannot expect to discuss a book on ethics without trespassing over other cultivated ground. The very nature of the subject invites excursions;

there is no trespass without wilful damage, and a little *Ausflug* can be wholly innocuous. Such a venture is rendered attractive by what Dr. Ewing has to say about art, or rather about works of art. 'Right' and 'harmonious' are words applicable to composition and balance; it is possible perhaps to go further and to assert that any "*merely* [my italics] rational analysis" is wholly incapable of adequate discernment in matters of æsthetic fittingness. The interesting thing is, however, that this is precisely the upshot, in analytic form, of Ruskin's lovely passage in his "Law of Help" ("Modern Painters", vol. 5), wherein he stakes his all upon composition as an individual achievement. Without it there is no picture; it is the creation of *that* artist, and of nobody else.

All these meditations may serve to show how rich in content is "The Definition of Good", and more, how valuable in suggestiveness. The historical pattern of ethical thought is present throughout as an unobtrusive background against which the author hangs his own definition, set off in a delicate frame. Yet he will not expect a crowd to be there gazing at it; in a better world there might be,

"But knowledge to their eyes her ample page
Rich with the spoils of time did ne'er unroll. . . ."

F. I. G. Rawlins

OPERATIONAL CALCULUS AND ITS APPLICATIONS

Modern Operational Calculus

With Applications in Technical Mathematics. By Dr. N. W. McLachlan. Pp. xiv+218. (London: Macmillan and Co., Ltd., 1948.) 21*s*. net.

THIS book is intended as an introduction to operational calculus based upon the transform of $f(x)$ defined by

$$\varphi(p) = p\int_0^\infty \exp(-pt)f(t)dt,$$

that is to say, the Laplace transform multiplied by p. The function $\varphi(p)$ so defined is identical with what Heaviside called the operational form. The advantage of the present treatment over Heaviside's is that the theorems of operation can be placed upon an impeccable basis without the necessity for acts of faith. The contents are: 1, the Laplace transform; 2, rules of the operational calculus; 3, solution of ordinary linear differential equations with constant coefficients; 4, solution of partial linear differential equations with constant coefficients; 5, evaluation of integrals; 6, derivation of Laplace transforms; 7, Laplace transform for a finite interval; impulses.

This last chapter is stimulating and makes accessible the theory of a method of outstanding importance. There are six appendixes concerning matters on which the reader should be more fully informed. These articles form what the author calls the "mathematical limit gauge". Indeed, a valuable feature of this work is the actual checking of the validity of operations, such as inverting the order of integrations, integration of infinite series, term-by-term differentiation and so on.

Although the book is intended for postgraduate engineers and technologists, it will be seen from the foregoing remarks that the presentation is more rigorous than is usual in this kind of work. This departure is greatly to be welcomed, for should a costly design be based upon intuitive reasoning and the reasoning prove false, the result may be disastrous.

This book will no doubt appeal to a wider class of readers than the author expects. It should certainly be regarded as indispensable by all engaged in the many branches of science in which the operational calculus, to which Dr. McLachlan has made important original contributions, is a powerful tool.

L. M. Milne-Thomson

AN INTRODUCTION TO RADIO ENGINEERING

Essentials of Radio

By Morris Slurzberg and William Osterheld. Pp. xii + 806. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 36*s*.

THE object of this book, according to the preface, is to describe at an intermediate level the principles of operation of thermionic valves and their associated circuits. It is intended for students at technical institutes or for radio technicians wishing to improve their basic knowledge of the operation of radio and electronic equipment; and, while it deals primarily with the applications of valves and associated circuits to radio receivers and transmitters, it serves also to give a general background to other industrial applications of electronic techniques.

The book achieves its declared purpose very well. For this very reason, the serious engineering student proceeding to a university degree is not likely, however, to find it very useful. It is essentially a technician's rather than an engineer's text-book.

The reader is assumed to have an elementary knowledge of electricity and magnetism, the authors having wisely avoided the fault, all too common in books of this sort, of beginning their book with an elementary course on electricity and magnetism. The reader's knowledge is 'refreshed' at appropriate points by restating fundamental relations in elementary theory in an appropriate practical form. Though the purist will find something to complain of in many of these practical restatements, the class of reader for whom the book is primarily intended is not likely to suffer much on account of an occasional lack of rigour. The analogy between radio and coal supply in Chapter 1 seems rather unnatural, and is unlikely to add to the understanding of the subject.

In spite of the title, the book deals almost exclusively with equipment. Wave propagation, though briefly mentioned, is not dealt with adequately. The appendixes provide much useful reference data in a convenient form, although, of course, the symbols and terminology are American, as also is the bibliography. From the point of view of the British reader, at least, the latter point is rather a pity since, though the field is necessarily not so large as the American, there are a number of British publications which could usefully have been included.

The book is excellently produced, as we have come to expect of books from these publishers, and the radio technician and others concerned with the operation and maintenance of electronic equipment will find it a useful general text- and reference-book.

W. R.

A Hundred Years of Chemistry

By Prof. Alexander Findlay. (100 Years Series.) Second edition. Pp. 318. (London: Gerald Duckworth and Co., Ltd., 1948.) 21*s*. net.

THE numerous admirers of Prof. Alexander Findlay's writings will welcome this new and revised edition of a remarkably interesting and useful book. His masterly review of a century of effort and achievement in the constantly widening domain of chemistry constitutes a great tribute to the author's power of taking a comprehensive view of a subject of bewildering complexity and expressing it in a way as attractive as informative. The book offers something to all who have an interest in chemistry; its character is such that it will be equally at home on the chemist's favourite bookshelf or in the lending or reference section of a library.

The new edition takes cognizance of the outstanding advances that chemistry has made in the last ten years, notably in the fields of atomic constitution, artificial transmutation of elements, nutrition, and medicinal specifics. During this fateful period, as the author remarks, "we have been the witnesses of one of the greatest achievements of the human mind, the utilization of atomic or nuclear energy. That this great achievement should have found its first use in human and material destruction by an atom-bomb is one of those tragedies which are a constant challenge to man's moral nature but which do not diminish the greatness of the achievement or make more difficult the application of man's knowledge to beneficent ends." In this work Prof. Findlay maintains his high reputation for accuracy; the only error of any note that has caught the eye of one with a peculiar interest in the immediate subject is the usurpation of hydrogen by hydroxyl in the molecule of chloroiodomethanesulphonic acid (p. 65).

The numerous footnotes illuminate in a striking way the writer's painstaking care and industry in going to original sources for his detailed information. The thumb-nail sketches of celebrated chemists given at the end of the book under the heading of "biographical notes" are very apt and replete with the concise facts so often needed and so hard to find.

JOHN READ

Historical Geology

The Geologic History of North America. By Prof. Russell C. Hussey. Second edition. Pp. xi+465. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 19*s*.

THIS account of the geological history of North America is intended for students and readers interested in the cultural aspect of the science. The author, like all geologists, believes that a knowledge of the major events in the history of the earth should be part of a liberal education. Since a new edition has been called for only three years after the first publication of the book, it appears that he has attracted the public he desires and deserves. This revised edition has been simplified by removal of some material (an all too rare operation in the preparation of new editions) and has been brought up to date, and better illustrations have been given where possible.

The arrangement follows that of the first edition. First are presented the general principles of historical geology, the organisation of the geological record, the nature and significance of fossils and the main concepts of evolution. Special aspects of these general principles are developed in the account of the geological history of North America which follows. For example, the causes of marine transgressions are discussed with the Cambrian, the habitats of marine animals with the Ordovician, coral reefs with the Silurian and so on. For each geological period, the lands and seas and their sediments, the climate, crustal disturbances and life are dealt with in this order so that the story keeps moving. Emphasis throughout is placed on the development of life in this story, and this emphasis is increased as we approach modern times. The account of Tertiary life includes the geological history of the horses, elephants and other mammals, and the last chapter, one of more than thirty pages, deals with that of man. The illustrations, many from the great American museums, are abundant and mainly excellent. In spite of its sub-title, this book will be of service outside the United States as well as within, for it presents the broad essential principles by which the history of the earth's crust everywhere should be read.

The Mineral Key

By Howard B. Graves, Jr. Pp. viii+178. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 20*s*.

MOST of this small book consists of mineral identification tables which are preceded by introductory chapters on equipment and chemicals needed and methods of identification. The determinative tables list some six hundred minerals, classified primarily according to colour, streak, cleavage and presence or absence of water, but optical properties and specific gravity are not included. Isomorphous series are each shown under one species, and varieties are omitted: amethyst and agate are, for example, excluded although many rare minerals are listed. The tables will be useful to experienced mineralogists, more particularly for determining opaque minerals; but in a book intended for amateurs more emphasis should, perhaps, have been placed on the caution necessary in identifying minerals with certainty. The price seems rather high for a book of this format.

P. A. S.

Insect Pests of Glasshouse Crops

By Prof. Herbert W. Miles and Mary Miles. Second edition, revised. Pp. 200+24 plates. (London: Crosby Lockwood and Son, Ltd., 1948.) 15*s*. net.

A SURPRISINGLY large number of species of insects and related small animals occur in glasshouses and cause injury to the plants that are grown therein. A perusal of the present handbook will convince the reader on this point: at the same time it will enable him (or her) to recognize any of these creatures that he is likely to come across. The grower, whether he has only a conservatory or farms an acre or more of glasshouses, will find just the sort of information that he needs and what control measures are best suited for any particular enemy of his plants. The first edition of the book appeared in 1935, and the present issue is a revised version with some modification as regards the presentation of the text and the addition of several new illustrations. Since the book no longer has pages of trade advertisements incorporated, the increase of price from 8*s*. 6*d*. to 15*s*. is reasonable under present-day conditions. Well printed and illustrated, and with a good index, it is indeed excellent value for the price.

A KINETIC APPROACH TO THE THEORY OF THE STRENGTH OF GLASS

By S. M. COX
Wear Glass Works, Sunderland

THE theory advanced by A. A. Griffith[1] in 1920 has served as a background to subsequent theories of rupture in brittle materials. The solid is regarded as an elastic continuum containing microscopic flaws, and the failure of the material under a stress less than that corresponding to the 'theoretical strength' (that is, as estimated from the heat of vaporization, or from Van der Waals' equation) is attributed to the enhancement of the stress in the locality of the flaws rather than to any intrinsic weakness of the material itself. Subsequent theories[2,3] have assumed the acuteness of the flaws to be modified either by chemical attack by the atmosphere or by viscous yield in order to account for the apparent decrease in strength of glass with increasing duration of load. This is but one of the difficulties which can only be met by rather artificial additions to the theory.

The advance in recent years of the theory of liquids suggests that a kinetic approach might directly resolve many of the difficulties—at least in so far as glass is concerned. Broadly surveying the phenomena connected with the fracture of glass, one is impressed by the consistency of some aspects and by the consistently variable nature of others. The glazier's control of the crack-direction, the geometrical simplicity of some crack-systems—the simple conchoidal crack and the familiar helixical cracks in tubing—these aspects are suggestive of elastic-continuum crack-propagation initiated by a flaw. On the other hand, there is the spread of results under tensile test, the dependence of strength on time, on sample size and on temperature; if these effects arise from intrinsic properties of the glass and are not due to the experimental conditions, an element of time, an element of size and an element of energy are to be accounted for. An atomic view provides three such intrinsic elements: there is the period and the energy of vibration, and the size of the atoms or ions themselves, and it is conceivable that the observed phenomena might be some macroscopic manifestation of the discrete nature of glass.

Kinetic treatment has been neglected on the grounds that the activation energy necessary for the spontaneous formation of flaws is too high, in comparison with the thermal energy, for the possibility of such an origin of flaws to be a significant factor except near the boiling point. This would certainly seem to be the case if one accepts Griffith's estimate that at least 10^6 atoms must synchronize and be in phase to initiate rupture. A little consideration will show, however, that this possibility cannot be dismissed so lightly. In the first place, a local discontinuity of any kind must cause a stress enhancement of the same type as that caused by a crack, and a local change in state of the material must provide such a discontinuity. There is now ample evidence to support the contention that atomic configuration-changes, characterized by comparatively small activation energies, can take place in glass. The large differences in volume associated with these changes become apparent in the annealing range. The necessary activation energy may then correspond to the annealing point rather than to the boiling point. Further, in the case of such 'configuration-flaws', the critical size, which must be achieved if the flaw is to grow, will be set by the relative stabilities of the two types of configuration and not by Griffith's criterion—which latter defines only the subsequent stage in the rupture sequence where the configuration-flaw gives place to the first true rupture. Finally, an immense number of opportunities are provided for the occurrence of a local accumulation of energy. The energy is so rapidly interchanged (vibration frequency 10^{12} cycles per second) and the atoms so numerous (Avogadro's number 10^{23}) that in a test lasting one second on 1 c.c. of glass the rare event is sought some 10^{35} times.

The problem of expressing the tensile strength in kinetic concepts must turn on the question of determining the conditions under which a local disorder will become cumulative. On Maxwell–Boltzmann theory all energies are possible, so there is no difficulty in supposing a single atom to become sufficiently energetic to leave its site in the array. The atom can only retain this energy for a time comparable with the period of its oscillation, unless its immediate neighbours are equally energetic. This event would also provide the opportunity for configuration-change, so that both the energy and the opportunity for a configuration-change would occur where a group of (say w) neighbouring atoms becomes activated. The experiments on annealing-range configuration-changes disclose that they are pressure-sensitive and reversible. If then the event in which the w atoms become activated occurs under stress, because this occurrence causes a stress enhancement at the boundaries of their locality, there will be a critical value for w, for larger values of which the extent of the configuration-flaw will grow and lead to eventual rupture, while for smaller values the flaw will have but a transient existence.

Taking into account the reversible nature of the change, an expression can be derived for the probability of such an event in terms of the temperature and stress. Assuming that each such event will lead to rupture, the tensile strength is given by setting this probability equal to one half—in accordance with the usual definition of the breaking point as that stress at which the chances of rupture and survival are equal.

$$\frac{\nu N t}{\tau}\left[A\left(\exp\frac{S}{kT}-C\right)\exp-\frac{B}{kT}\right]^{w}=\frac{1}{2}.$$

In this expression νN is the number of different ways in which the w neighbouring atoms constituting a flaw-nucleus may be chosen out of the N atoms in the sample under a stress proportional to S; t is the duration of test, and τ the vibrational period of the atoms. A and C are constants depending upon the composition and temperature of the glass, and B is the activation energy for the configurational-change involved. It will be noticed that there is a minimum tension corresponding to $S = kT \log_e C$ below which the glass should not break, however large the sample or prolonged the test.

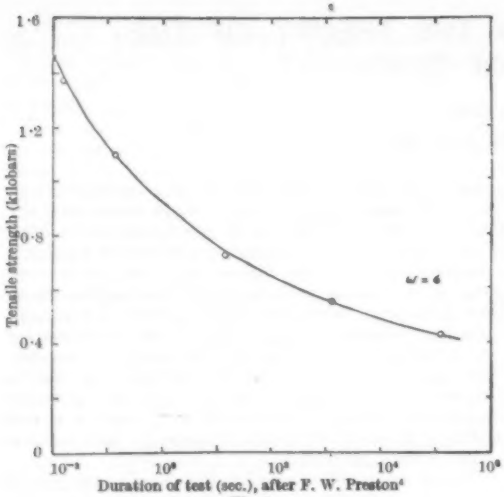

Fig. 1

The relations between strength, duration of test and sample size given by this expression are in good agreement with experiments, as may be seen in Figs. 1 and 2. The spread of experimental results is also predictable (Fig. 3). In all these figures the full line represents the calculated results and the crosses or circles the observed values. The derivation of the formula is given in more detail in work already published[9].

In making these comparisons the value of w must in most cases be found by trial. It is natural to suppose that the value of w for a surface flaw would only be half that for an internal flaw, for on purely geometrical grounds a flaw of half the volume of an internal flaw would be equally weakening on the surface—in the same way the roughness of the surface on an ionic scale will influence the strength because of the smaller value of w required to make an equally effective flaw. One has then the same type of explanation of surface effects as in Griffith's theory, but on a sub-microscopic level. One of the troubles with Griffith's findings was that his flaws should be visible, and at least in the ordinary course of events there is no visible evidence for them. On the contrary, as Murgatroyd has shown, visible single scratches are sometimes ineffectual in weakening the glass. This is an interesting point, because on the basis of the above equation, such a scratch—in spite of the enhanced stress at its edge—is not necessarily the most probable origin for the breakage; the size of the sample (N) must also be taken into account, and where the size is reduced to the area of the scratch, the probability of breakage from this particular locality is reduced in the ratio of this area to the effective area of the whole sample.

Another feature of brittle rupture which finds a ready explanation on this theory is the behaviour of the crack-propagation velocity and the nature of the broken surface. The velocity of crack-propagation is set by the calculable probability of the atoms at the crack-tip becoming activated. It has a maximum corresponding to the requirement that the energy cannot be transferred from atom to atom in a time less than τ. When this maximum is reached, there is no corresponding limit in elastic theory to the stress-enhancement due to the flaw; and a stage is reached at which the probability of breakage is not limited only to the crack-apex; but cracks also develop at an angle to the principal stress. This is the point at which the mirror surface gives place to the hackled surface so often observed on broken surfaces.

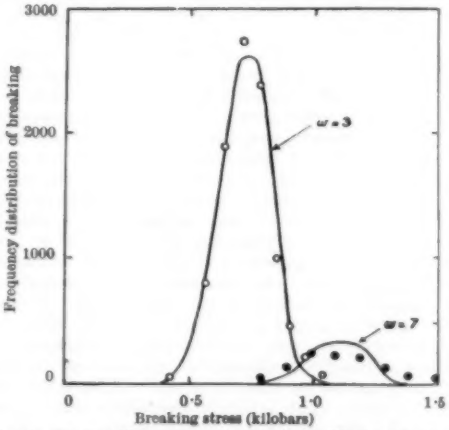

Fig. 3. o—o—, 9983 samples, after B. P. Dudding[7]; ●—●—, 115 fire-polished samples, after Holland and Turner[6]

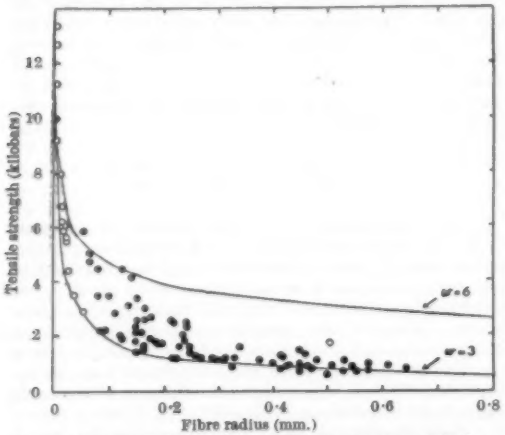

Fig. 2. o—o—, Data by A. A. Griffith[5]; ●—●—, data by E. J. Gooding[6]; ● — ● —, acid-polished specimens

The numerical assessment of the probabilities and the determination of the effect of temperature on the strength of glass is made difficult because one cannot assume that all atoms have average activation energies. A consequence of the random arrangement of the atoms must be a spread of activation energies, and as those of lower value are obviously of most significance, it would be necessary to have some knowledge of the shape of the distribution curve. Assuming the distribution of activation energies to be similar to the distribution of inter-ionic distances from X-ray data, a crude estimate can be made, and in this way it is found that the product of the quantities on the left-hand side of the equation given may well be of the right order, that is to say, one half.

To summarize, if the strength of glass does depend on the spontaneous development of flaws under the applied stress in the way described, then breakage

can only occur if the stress exceeds a certain minimum. Above this minimum stress the probability of breakage increases with sample size and with time for the same reason, namely, that such increases provide increased opportunity for the rare event which is automatically recorded by the fracture of the specimen.

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MINIMUM OXYGEN LAYER IN THE OCEAN

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THE fact that there is in every ocean a zone of minimum oxygen is of interest not only to the physicist and chemist but also to the biologist, and it is very desirable that we should know what influence this layer has on both the quantitative and qualitative distribution of the fauna, or, alternatively, whether this layer is to be attributed to the biological activity of the fauna and especially of the plankton. The facts that we possess regarding this problem are very impressive and are somewhat contradictory.

The depth at which this minimum oxygen layer is found differs in different oceans and in different regions of the same ocean. In the Atlantic its depth below the surface varies from 350 to 900 m. In the Indian Ocean, according to the results obtained by the *Dana* and the *Mabahiss*, the distribution of oxygen is less simple; the oxygen content of the tropical surface water decreases abruptly within the thermocline to an intermediate minimum, which at all stations north of the equator is found at a depth of about 150 m.; below this level the oxygen content of the water increases slightly and then again falls abruptly in those regions in which the Indian Intermediate Current flows southward at a depth of approximately 250–1,500 m., and at this depth the actual content may be well below 0·1 ml. per litre. In the Pacific the depth of this layer varies between 400 and 1,000 m.

Le Danois[1] considers that this zone of minimum oxygen is the result of stagnation of the water at this depth and the presence of what he terms 'fossilized' water. Wüst[2] concludes that in the Atlantic Ocean between lat. 45° S. and 20° N. the layer of minimum oxygen coincides with the boundary between the surface stratum and the Antarctic Intermediate Water, while farther north it marks the boundary between the surface water and the water that has flowed out of the Mediterranean Sea; he, too, considers that the low oxygen content is the result of stagnation or of very slow horizontal movement. Wüst[3] also claims that over the greater part of the Atlantic Ocean the depth of the layer coincides with the 8° C. isotherm; but in the North Atlantic between lat. 30° and 45° N., owing to the influx of Mediterranean water, this isotherm lies about 600 m. below the minimum oxygen layer. Vallaux[4] points out that in the Atlantic between lat. 0° and 20° N. the fall in the oxygen content, which commences at 200 m., reaches a minimum at the 400–800 m. depth, and thus stands in close relationship to the complete disappearance of the phyto-plankton and to the relatively great abundance which the zoo-plankton manifests at this level.

T. G. Thompson[5] and others show that there is a marked correlation between the minimum concentration of oxygen and the maximum concentration of carbon dioxide, and they claim that the reduction of oxygen is due almost entirely to the oxidation of organic matter at this depth. Seiwell[6] stresses that the minimum oxygen concentration may primarily be due to either a proportionally greater oxygen consumption per unit of time or a slower renewal by horizontal currents; and he suggests that biological activity plays an important part in fixing the minimum oxygen concentration at mid-depths. This may be brought about by a maximum concentration of oxidizable organic matter at the depth of the minimum oxygen concentration, or, if the supply of oxygen by horizontal currents varies with depth, by vertical variations of biological activity, causing the ratio, oxygen utilized/oxygen supplied, to be continuously increased as the depth of the minimum oxygen concentration is approached both from above and below. He points out that the minimum oxygen concentration in the western North Atlantic tends to occur at the level of the density value $\sigma_t = 27{\cdot}232 \pm 0{\cdot}008$, which implies that the settling velocities of organic particles are perceptibly slowed at this level, resulting in an increase of oxygen consumption per unit time. He adds, "however, the results of oceanic biological investigations have not yet furnished evidence for the adoption of this hypothesis".

Redfield[7] claims that it has been found that in the North Atlantic the phosphate maximum and oxygen minimum may be derived chiefly from the oxidation of organic matter within a few hundred metres of the surface in the region about lat. 40° N., and further that in the equatorial region additional phosphate is added to and oxygen removed from the water by processes other than isentropic movement, namely, by the sinking of decomposing organisms from the surface of the tropical ocean to considerable depths. In the belt between lat. 20° S. and 25° N. it is difficult to explain the observations without assuming that active decomposition is occurring down to a depth of at least 600–800 m. Harvey[8] maintains that the reduced concentration in the oxygen-poor layer is due, in part, to consumption of oxygen during the oxidation of falling particles of organic matter, coupled with slow renewal through eddy-conductivity from the surface layer and from the deep water below; minimum values are found in the most stable part of the water column, where the density of the water is increasing most rapidly with depth, and, furthermore, the size of these particles decreases rather rapidly with time. Thus we are faced with the question, "Is this oxygen consumption caused by bacterial action on dead or decomposing organic particles?"

Redfield[9] has pointed out that the quantity of such falling organic debris is not great in the relatively

barren areas of the Atlantic, and that its oxidation is likely to be nearly complete before it has fallen as deep as the layer where the least oxygen is found. The work of ZoBell and Anderson[9,10] has shown that the number of bacteria that could carry out this destruction of organic particles is high in the photic zone of the ocean in the top 20 m., but then decreases extremely rapidly until it is at a minimum at about 500-m. depth, increasing again rapidly at the bottom in the sediments. ZoBell[11] claims that "considering that most of the organic content of sea-water is highly refractory to bacterial oxidation, it appears that the concentration of organic matter is near the threshold of the requirements for bacteria, which probably accounts for the paucity of bacteria in the ocean". It would thus appear to be very doubtful whether the minimum oxygen layer can be attributed to the bacterial decomposition of dead organic matter, and one must therefore consider the possibility that the living plankton may be the cause.

It is frequently stated that the total amount of living plankton steadily and progressively decreases with depth, and Schott[12] has given figures that indicate this very clearly. Off the Californian coast, at five stations carried out in 1933 at a point 100 miles west of Cape Arguello in Central California by the steamship *Pioneer* of the United States Coast and Geodetic Survey, the total plankton showed a steady decline from the surface downwards, and the minimum oxygen layer, with a concentration of oxygen as low as 0·2 ml. per litre, lay at a depth of about 100 m., with an increase of oxygen to more than 2·0 ml. per litre at greater depths. Hauls with the Nansen closing-net over intervals of about 100 m. showed that the total amount of plankton appeared to decrease uniformly with depth, so that there was less plankton below the oxygen-minimum layer than in it. Dr. Revelle, who participated in these investigations, states that at the time he thought that the controlling factor for the plankton concentration was food-supply, that is to say, organic material settling from the photosynthetic zone near the surface and being eaten as it sank. Sverdrup, Johnson and Fleming[13] (p. 872) state that on the coasts of California the diminution of pelagic life with depth is not in agreement with that of oxygen, since between 150 and 800 m. oxygen is almost entirely absent, but one captures Copepods and other planktonic forms at these depths. Bogorov[14] reached the same conclusion regarding the distribution of the Copepoda in the White Sea and Barents Sea. But this steady decrease in the quantity of plankton with depth does not always hold good. In the Gulf of Panama, A. Agassiz[15], during the cruise of the *Albatross*, found between 366 and 732 m. depth an azoic zone which contrasted strongly with the richness of life observed above and below this depth, and it is between 400 and 500 m. that in this region one finds the zone of minimum oxygen (0·6 ml. per litre). In the same region the observations made on board the *Dana* by Joh. Schmidt[16] and P. Jespersen[17] show a remarkable quantitative difference in the plankton; they found, in contradistinction to the observations of others, that the plankton is incomparably richer at a depth of 1,000–1,500 m.w. (500–750 m. depth) than it is nearer the surface at 50–300 m.w. (25–150 m. depth); the volumes captured per hour for a net having a diameter at the mouth of 1·50 m. are, on the average, 527 c.c., as compared with 262 c.c., the observed minimum of 105 c.c. occurring at a depth of about 600 m.w. (300 m. depth).

A study of the hauls of Copepoda made at different depths by various expeditions in different regions seems to indicate that, as one passes from the surface to greater depths in the tropical region, there is at first a steady reduction in the number of both species and individuals until one reaches a depth of some 400–500 m.; the species inhabiting this upper zone are clearly warm-water, surface-living forms. At this point the curve changes its direction and the number of species and individuals begins to rise again; these latter species are cool-water, deep-dwelling forms. The greatest concentration of individuals of these deep-dwelling species occurs at some distance above that of the greatest concentration of species, and in most cases seems to fall near the level of the zone of minimum oxygen (Sewell[18]). In this connexion it is of interest to note the results obtained during recent under-water sound investigations that have been carried out by the United States Navy Electronics Laboratory, San Diego, California. These investigations have revealed the presence of a deep layer in the ocean that causes a scattering effect. This scattering layer lies at or near the surface at night; but before sunrise it commences to descend and during the day-time is found to lie at depths ranging from 150 to 450 fathoms (274 to 823 m.); in the evening, starting before sunset, it ascends again to the surface. This layer seems to be present throughout the tropical and temperate regions of the Pacific, but was absent or only sporadically present in the Antarctic during the period of almost permanent daylight. In some regions double or even treble layers were detected at different depths.

It has been suggested that these layers of scattering may be due to the presence, and to the daily vertical migration under the influence of light, of a concentration of zoo-plankton, and that the double or triple layers may indicate that different species, or different stages of development of the same species, may be implicated. The most common depth at which the scattering layer was found is about 350 fathoms (640 m.), and hauls with the closing-net gave evidence that at about this depth there seemed to be indications of a considerable increase in the numbers of Euphausians and *Sagitta*.

Sverdrup, Johnson and Fleming[13] (p. 730) remark that "a few scattered observations indicate that organisms are found even when the oxygen content is as low as 0·1 ml. per L.". During the *John Murray* Expedition several hauls were carried out at intermediate depths at certain stations in the Arabian Sea; in each case the net used was one having a diameter at the mouth of one metre. Here the minimum-oxygen layer lies at a depth of 600–1,000 m., and in the table below is given the actual numbers of four species of Copepods that were taken in this zone:

Station identity number	186	172	76	172	76
Depth in m.	0–250	0–400	0–600	0–850	0–1500
Eucalanus attenuatus	—	250	—	473	—
" *elongatus*	191	302	2,061	567	351
Rhincalanus nasutus	167	744	803	1,249	—
Pleuromamma xiphias	—	222	—	247	—
Oxygen concentration in ml. per litre	0·536	1·02	0·323	0·455	1·09
Duration of haul	1 hr.	2 hr.	1 hr.	2 hr.	1 hr.

The main haul was taken at the maximum depth indicated. These observations clearly point to the presence of a flourishing population, belonging to several species, in this zone of minimum oxygen; and for the maintenance of this relatively rich fauna there must be an equally rich food-supply.

Another point of interest is to be found in the prevalence at these intermediate depths of species that possess a red or purple coloration; this is particularly striking in the Crustacea and in certain species of fish. Above this level, planktonic animals tend to be colourless, while below it many species of fish are brown or black. In the words of Sverdrup, Johnson and Fleming, "the further examination of the distribution of such organisms and their adaptation to the extreme condition represents one of the fascinating biological problems".

Another problem that requires investigation is whether this minimum-oxygen layer forms an obstacle to the admixture of surface-living forms with those of greater depths. In this connexion Dahl[19] has pointed out that a large number of species of Copepoda are to be found in the upper stratum, while below this lies a second, extending down from about 300 to 1,000 m., in which there are only a few Copepods that are common to the upper layer; and the few species that are common to both strata are mostly rare in one while being numerous in the other, in which they are really at home. It is interesting to note that Grace Pickford[20] in a study of *Vampyroteuthis infernalis*, captured by the *Dana*, shows that the vertical distribution of this Cephalopod appears to be limited in all the oceans by the zone of minimum oxygen. According to Torsten Gislen[21], the minimum-oxygen zone will equally play a part in the distribution of the benthonic species; basing his conclusion on the catches of Echinoderms made by the *Albatross* off Panama and the California coast, he believes that not only is there a remarkable paucity of the fauna at a depth of 500–600 m., but also he shows that the species above and below this level are entirely distinct.

It is thus abundantly clear that a detailed study of this zone and of the fauna that inhabits it, as well as a comparison of the faunas above and below it, present a number of problems that are of considerable interest, not only to the taxonomist but also to the physiologist and biochemist; and it seems worth while, now that oceanographic investigations are once again being contemplated or actually carried out, to direct the attention of investigators to this zone.

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USE OF LIQUID FUELS

CONFERENCE AT BIRMINGHAM

IN scientific research, and in the application to industry of the results of research, the problems encountered are of increasing complexity. Scientific workers engaged in this work feel the necessity for consultation or collaboration with specialists in fields other than their own. Indeed, it has become a commonplace that most industrial research problems require teams of experts from many branches of science and engineering. The interdependence of the various branches of science and technology has long been recognized; but collaboration between the corresponding societies has been practised to a noticeable extent only in comparatively recent years. Joint conferences, such as that held at the University of Birmingham during September 21–23, are therefore welcome not only for their immediate value, but also as tokens of the growing integration of science.

The Birmingham Conference on "Modern Applications of Liquid Fuels" was organised by the Institute of Petroleum and the Institute of Fuel, in recognition, as Mr. J. A. Oriel, the president of the Conference, put it, of their joint responsibility for ensuring that all kinds of fuel available in Great Britain are used with maximum efficiency. The scope of the Conference was wide, and while the use of oil fuels for prime movers, as in petrol and Diesel engines, was in general excluded, the seven sessions, into which the Conference was divided, furnished opportunities for the exchange of information, experience and opinion about the design, operation and performance of burners and furnaces, agricultural driers, Diesel rail traction-engines, the use of oil in the gas industry, and the principles of combustion-chamber design for the gas turbine.

One evening was devoted to a lecture on the uses of liquid fuel in domestic heating, largely based on the work of the Liquid Fuel Installations Committee of the Institute of Petroleum. This Committee is preparing a report on the use of liquid fuels for domestic heating at the request of the Minister of Fuel and Power, similar to the Post-War Building Studies arranged by the Ministry of Works in reference to electricity, gas, and solid fuels. The oil fuels chiefly used, for both space- and water-heating, are liquefied butane and other gases, kerosine, and Diesel oil. The development of modern domestic appliances burning kerosine was described, and attention was directed to their high thermal efficiencies; such appliances have many advantages in rural areas.

The Conference was concerned in the main, however, with the industrial application of oil fuels for purposes for which coal and petroleum may be used alternatively, and the chief scientific interest of the Conference, therefore, was the opportunity which it provided for making a comparison of the two fuels. In Great Britain, coal always has the advantage of lower cost, and the opinion is widely held that but for this advantage, oil would always be used in preference to coal. Oil has a higher calorific value, and is certainly easier to handle and store than is coal; and it is cleaner in use—qualities which account, for example, for the replacement of coal by oil for use at sea. Petroleum, moreover, has a very small content of mineral matter; this becomes concentrated in residual fuels by distillation, and the use of distillate fuels is accordingly entirely free from

the troubles due to ash-formation which are associated with the use of coal. The same is, however, not true of residual fuel oils; although ash-formation is much less than with coal, it may give rise to serious problems, as, for example, in the gas turbine, where ash-deposition is a major obstacle in the development of this prime mover to use heavy fuel oils. Fuel oils, of course, still have a great advantage over coal in this connexion; but it is important to realize that the use of oil is by no means entirely free from the problems which attend the use of coal. Thus both fuels contain sulphur, and the fuel oils available for use in Great Britain often have high sulphur contents (two per cent or more) which may cause deterioration of product quality in the steel and metal industries. In this respect, therefore, the advantage frequently lies with coal or the fuels derived from it, namely, producer-gas and coal tar.

The oil flame has a higher radiation efficiency than the gas flame—a property which has contributed to the improved results which have been obtained in the manufacture of steel in the open hearth furnace by conversion to oil firing. Several other factors are, however, also involved, and there was considerable divergence of opinion at the Conference as to the relative merits of oil and coal in this and similar applications. In some instances, conversion to oil firing has shown little advantage; but the bulk of the evidence supports the conclusion that it leads to greater steel production. It is, in fact, probable that the use of oil has made an important contribution to the record steel output in Britain now being obtained. It cannot, however, be immediately concluded that conversion from coal to oil firing is necessarily advantageous to the steel industry.

In the first place, consideration must be given to the cost of any technical advantage, and the differential price of coal and oil in any particular locality is clearly a most important factor. This is illustrated very clearly by the American experience which was recorded in one of the papers contributed to the Conference. The steel industry in the United States was originally based on coal; but oil firing was adopted, at a time when fuel oil was relatively very cheap, with a consequent increase in thermal efficiency and steel production. At present, however, the supply position and the changing price differential have started a reverse trend from oil to coal firing. The combined use of oil and coke-oven gas has given good results, and it is suggested that other combinations, including such fuels as coke breeze and powdered coal, might be used with advantage.

A second factor in the achievement of improved results with oil firing is the greater ease of control which attends the use of oil. Partly in consequence of this, the application of oil firing has usually been made with greater instrumentation and scientific control, and it seems likely that improved results could also be obtained with producer-gas if similar methods were employed. This consideration suggests that the comparison between oil firing and conventional practice with producer-gas has not always been fair to the latter. It is certainly also true that the comparison has sometimes been unfair to oil firing because of unsuitable furnace design. Thus it has been shown that the jet action due to the greater velocity of the oil flame may result in a serious air inleakage which could be avoided in a furnace designed specifically for the utilization of oil.

The use of fuel oil in glass furnaces also gives the advantages of greater ease of control and increased rate of glass melting, but the intense radiation from the oil flame results in increased wear on refractories; and although increased efficiency could be obtained by greater preheat of the combustion air, it is concluded that oil firing is not at present economic in comparison with an efficient producer-gas system. It is evident that the assessment of the relative values of coal and oil firing involves many technical and economic factors.

It is not possible, in this short article, to do justice to the vast amount of technical information which has been provided by the many papers contributed to the Conference. Readers interested, for example, in the application of the Diesel engine to rail traction, in modern developments in agricultural drying processes, or in any of the other modern applications of liquid fuels in the field already indicated, will be well advised to consult the Conference records; when published, these will constitute a valuable work of reference which will perhaps be the major achievement of the Conference.

F. H. GARNER

OBITUARIES

Dr. S. E. Sheppard

SAMUEL EDWARD SHEPPARD died in Rochester, N.Y., on September 29, aged sixty-six. Dr. Sheppard was born in Catford, and was educated at St. Dunstan's College, Catford, and University College, London. There he obtained the degree of B.Sc. by research in 1903, his thesis dealing with the theory of the photographic process and involving a repetition and extension of the earlier work of Hurter and Driffield. This work was greatly extended in his research for the D.Sc. degree, which was granted in 1906 for a thesis which was published in 1907 jointly with that of C. E. K. Mees under the title of "Investigations on the Theory of the Photographic Process". Much of the work had been published in a series of papers in the *Photographic Journal*, the *Transactions of the Chemical Society*, and in the *Proceedings of the Royal Society*.

In 1906 Sheppard was awarded an 1851 Exhibition for two years and went to Marburg, where he worked with Karl Schaum, professor of photo-chemistry and the editor of the *Zeitschrift für Wissenschaftliche Photographie*. Sheppard's work was on the molecular structure of sensitizing dyes and particularly of pinacyanol, the red sensitizer discovered only a short time before by Homolka, of the Hoechst dye-works. The study of the structure and behaviour of dyes like pinacyanol continued to attract Sheppard's attention throughout his entire life. After a year in Germany, Sheppard went to Paris, where he worked with Victor Henri at the Sorbonne on colloid chemistry.

In 1913 Sheppard accepted an invitation to take charge of the sections of physical and colloid chemistry in the Kodak Research Laboratory, which had just been organised under the direction of C. E. K. Mees at Rochester, N.Y.

His early work there dealt principally with the physico-chemical properties of gelatin, and a number of papers were published dealing with the measurement of the viscosity of gelatin solutions, the measurement of the jelly strength and the elastic properties of gelatin jellies, the setting and melting points of gelatins, the drying and swelling of gelatin, and the structure of gelatin in solution, in the jelly,

and in the dry state. These early papers deal primarily with the definition of the properties to be measured, with methods of measurement, and with instruments for making the measurements. As soon as the methods were so perfected that reproducibility was possible, it became evident that further progress in the realm of the physical and chemical properties was dependent on the nature of the sample. This work culminated in 1929 in a description of a procedure for making a standard gelatin by methods easily reproduced in the laboratories. A scientifically valuable by-product of this work was the manufacture and consequent availability of such a standard de-ashed gelatin to laboratories in general, biological as well as chemical.

After the First World War, Sheppard began to turn his attention to the structure and properties of silver halide emulsions, and his first work took the form of a study of the distribution of the sizes of the silver halide grains in an emulsion, the intention being to work out the relation between this distribution and the sensitometric properties of the material. Thus began a long series of studies that are not yet completed, though much progress has been made in the last thirty years. At the same time, working with Dr. Ludwik Silberstein and with Mr. A. P. H. Trivelli, Sheppard began to consider the action of light on the halides and the nature of sensitivity, and about 1923 a series of papers was published on the theory of photographic sensitivity and of exposure, which resulted in the presentation of the concentration speck hypothesis, according to which the sensitivity was related to discontinuities in the silver bromide lattice, presumably due to some foreign substance. At the same time, a very notable group of studies was going forward on the measurement of size frequency distribution, which led to the development of microscopic methods by which the grain-size frequency distribution could be measured for practical silver bromide emulsions.

The well-known sensitizing property of gelatin in the photographic process led to a systematic study of the difference between photographic gelatins in their sensitizing power and the nature of the substance in gelatin which conferred sensitivity. By a painstaking series of analyses, it was found that the sensitizer inherent in natural gelatin was concentrated in the liquors obtained by the acid treatment of the raw material after liming; and eventually it was found that the chemical properties of the sensitizer corresponded to those of allyl thiourea, and that therefore the gelatin sensitizer was essentially one which could produce silver sulphide specks in the silver bromide crystals.

This discovery is perhaps the major advance made in Sheppard's scientific career. All further study of the photographic properties of gelatin, of the nature of the sensitivity of silver halides and of the latent image have been conditioned by it. Its publication won for Sheppard instant recognition. He was awarded the Adelskőld Medal of the Swedish Photographic Society in 1929, the Progress Medal of the Royal Photographic Society in 1928, and the honorary fellowship of the Royal Photographic Society in 1926. In 1928 he delivered the Hurter and Driffield Memorial Lecture to the Royal Photographic Society, and in 1930 received the Nichols Medal of the American Chemical Society.

From that time, Sheppard's scientific work covered a prodigious range of knowledge. Besides the work on the latent image, he studied such matters as the photovoltaic effects, that is, the electrical response of silver halide to light, the colloidal structure of film-base materials and their physico-chemical and elastic properties, the nature of development, and particularly the nature of dye sensitizing, the adsorption of sensitizing dyes to silver halides, the structure of the layers which they formed, and their sensitizing effects.

Sheppard realized that the solution of the problem of dye sensitizing would involve not only the coupling of the dye to the silver halide lattice by absorption, but also an understanding of the nature of the absorption of light by the resonance structure of the dye. Thus he studied the absorption spectra of dyes in various solvents, in vapour phases, and when adsorbed to surfaces. This is the field which was chiefly engaging his attention when his health failed.

While never robust, Sheppard enjoyed good health until a few years ago, when he began to have trouble with his eyes, which culminated in the loss of one eye from glaucoma. At the same time, his heart was affected, and continued to fail until in January 1948 he found it necessary to resign from his position with the Kodak Company.

More than any other single worker, Sheppard has been responsible for our present knowledge of the theory of the photographic process. He explored every section of the chemistry of that process, and everywhere his studies brought light.

C. E. K. Mees

Prof. Kornél de Kőrösy

We regret to announce that Dr. Kornél de Kőrösy, professor of biology in the University of Budapest, died on July 14. Son of the famous Hungarian statistician, Joseph de Kőrösy, he was born at Budapest in 1879. As a student of medicine, he entered the Institute of Physiology in the University of his native city, never to leave it permanently until his death.

Until the First World War he was mainly interested in problems of metabolism, especially in those of resorption, and one of his publications foreshadowed the insulin problem. He spent at that time practically all his summer vacations at some world centre of learning. On one such occasion, in New York, Jaques Loeb invited him to stay at the Rockefeller Institute, where they were working together on osmotic problems; but Kőrösy decided to return to Hungary, which proved fatal for his life and career.

During most part of the First World War and some time after, he was acting director of the Physiological Institute, shouldering an unusual load of teaching in difficult circumstances. Anti-semitic racial prejudice, rising quickly after the War, forced him from this position and practically stopped his experimental work. He turned to genetics and developed a mathematical theory of coupling between genes, published as a long monograph in German. During the last ten years of his life he cleared up important problems on crossing-over interference.

Political terror made him conscious of his Jewish duties, and he soon rose to the presidency of the Hungarian Pro-Palestina Association. The Nazis deported his younger son, who failed to return. The months of terror, the loss of access to his precious library and files, even after the War, hastened his death.

Prof. Kőrösy belonged to those men whose respect for truth and justice was embedded in a nature fond

of beauty and full of humanitarian sentiment. He was a well-known figure at physiological congresses in Paris, Budapest, London, Boston, Leningrad, Venice, Edinburgh, and was loved for his kindly, gentle nature by friends and students the world over. Music was his favourite recreation, and he loved to travel, always taking his family with him. His wife, whom he married early in life, and three of his children, survive him. M. POLANYI

WE regret to announce the following deaths:

Sir Wilfrid Grigson, C.S.I., sometime director-general of revenue in Hyderabad, author of "The Aboriginal Problem in the Central Provinces and Berar" and other anthropological studies, on November 26, aged fifty-two.

Dr. Louis Rapkine, director of the Department of Cell Chemistry, Pasteur Institute, Paris, on December 13.

Dr. Marjory Stephenson, M.B.E., F.R.S., of the Medical Research Council Unit for Chemical Microbiology, on December 12, aged sixty-two.

We are glad to learn from Prof. J. Heyrovský, of the Charles University, Prague, that Dr. F. Běhounek, whose death was announced in *Nature* of December 4, is alive and well.

NEWS and VIEWS

U.S. National Academy of Sciences: Agassiz Medal

THE National Academy of Sciences presented the Alexander Agassiz Gold Medal and honorarium for 1948 to Dr. Thomas Gordon Thompson at the autumn meeting of the Academy held at the University of California, Berkeley, on November 15. Dr. Thompson, professor of chemistry and director of the oceanographic laboratories of the University of Washington at Seattle and Friday Harbor in the State of Washington, has long been a leader in investigations of the complex chemistry of the ocean, with special attention to the waters of the north-east Pacific, Puget Sound, the San Juan Archipelago and the Bering and Chukchi Seas. Under his inspiration and leadership, his associates and students have devised and developed effective methods and techniques for the isolation and the quantitative determination of many of the elements and their compounds which occur in minute concentrations in sea water. Examples of such are iron, lithium, silicon, manganese, aluminium, boron and radium, the fluorides, phosphates and silicates, the isotopes of the elements of water and the dissolved gases, and the ionic ratios of the major constituents of sea water in various parts of the ocean. In organising the oceanographic laboratories at Seattle and Friday Harbor, Dr. Thompson brought together specialists in the fundamental sciences associated with the various departments of a great university, and directed their attention and stimulated their interest in the many problems presented by oceanic phenomena. Dr. Thompson has been chairman of various international committees, particularly the committee of the International Association of Physical Oceanography, appointed for the purpose of establishing standard units and procedures for the promotion of studies of the chemistry of the ocean. Established by Sir John Murray in 1911, the Alexander Agassiz Gold Medal is awarded by the Academy "for original contribution in the science of oceanography to scientific men in any part of the world".

William Davidson of Aberdeen: 1648

A TERCENTENARY Memorial Lecture entitled "William Davidson of Aberdeen: The First Scots Professor of Chemistry" was delivered in Marischal College, Aberdeen, on November 26, 1948, by Dr. John Read, professor of chemistry in the University of St. Andrews. Davidson was a native of Aberdeenshire who graduated at Marischal College in 1617 and then migrated to France. Here he became known as an authority on medicine, pharmacy and chemistry. He gave instruction in medical chemistry of the Paracelsian type, and was appointed a physician to the French king. In 1647 he was nominated to the first chair of chemistry to be founded in France, at the Jardin du Roi in Paris, where he entered upon his duties in 1648. Davidson was one of the three earliest occupants of a chair of chemistry, and the first native of the British Isles to become a professor of chemistry. Owing to religious and medical jealousies, he was forced to resign the chair in 1651; thenceforward, until 1667, he was chief physician to the King of Poland. He died in Paris in 1669. Besides various medical works, Davidson wrote an early text-book of chemistry entitled "Philosophia Pyrotechnica". Although imbued with the ideas of his alchemical predecessors, and given to associating the doctrines of chemistry with religious and metaphysical conceptions, he has claims to be called a chemist rather than an alchemist. Davidson was particularly proud of the blue blood of Scotland that ran in his veins; in 1629 he obtained a patent of nobility from Charles I and thereafter styled himself 'Nobilis Scotus'. To account for his entering the medical profession he told his readers that "professors of medicine were invested with such honour by the kings of Scotland that they enjoyed a title equal to that of earls".

U.S. Scientific Mission to Japan

THE Supreme Commander, Allied Powers ('SCAP') has announced that a United States scientific mission to Japan "is scheduled to arrive in that country on or about November 26 and may be expected to remain until about December 18, 1948". The mission is composed of five distinguished American men of science, selected by the National Academy of Sciences, and includes: Dr. Detlev W. Bronk, chairman of the National Research Council, foreign secretary of the National Academy of Sciences, and president-elect of Johns Hopkins University; Dr. E. C. Stakman, chief of the division of plant pathology and botany, University of Minnesota; Dr. Zay Jeffries, vice-president of the General Electric Company, and general manager of its chemical department; Dr. I. I. Rabi, professor of physics, Columbia University; Dr. Roger Adams, head of the department of chemistry, University of Illinois, and chairman of the scientific advisory group that visited Japan in 1947. Dr. Bronk is chairman of the present mission. The new mission is making the visit at a time when some forty

thousand Japanese scientific workers, representing all fields of research, are participating in the election of 210 members for the country's first National Science Council. This election, due on December 20, is considered to be of unusual interest as it is thought to represent the first attempt of scientific workers of any country as a whole to elect members of its supreme scientific organ. The mission is expected to review progress made by Japanese men of science in the development of democratic national organisations for scientific activity. It is expected to bring up to date the report submitted by the previous advisory group; recommendations by that group served as guides to 'SCAP' sections in judging proposals of the Japanese for the reorganisation of national scientific bodies. The group proposes to spend approximately one day each in Sendai, Sapporo, Kyoto and Hiroshima; the remainder of the time will be spent in Tokyo in discussion with 'SCAP' personnel and Japanese scientific workers.

Vacation Work for Technical Students

THE fourteenth annual report for the year ending October 1948 by the Vacation Work Scheme of the Imperial College of Science and Technology has recently been published. The Scheme aims at providing work in Great Britain and abroad for students during their vacation, and it is almost entirely voluntary in nature. During 1948, 829 students participated as compared with 705 in 1947 (this increase being largely due to a greater number of overseas students); and this year's total was made up of 200 overseas students and 629 British, 194 of these latter having worked abroad. The bulk of the British students (591 in actual number) was drawn from the three Colleges which form the Imperial College, namely, the Royal College of Science, Royal School of Mines, and City and Guilds College. In January 1948 an international conference was held in London at the Imperial College to unify the procedure and minimize the correspondence for the exchange of students between different States; ten countries sent representatives and an organisation was founded called the International Association for the Exchange of Students for Technical Experience. During the recent summer vacation this Association has successfully exchanged 950–1,000 students between the participating countries. The next conference of this Association will be held in Copenhagen during January 3–7, 1949. As a result of the establishment of this Association, central organisations have been set up in each country; the governors of the Imperial College have decided to broaden their machinery, coping with international exchange, to include undergraduates from other universities and colleges in Great Britain, and this information has already been communicated. The aim is to make the scheme self-supporting, if possible, through an affiliation fee payable by each college concerned (based on the number of students sent abroad) together with a registration fee payable by the student. Offers of financial assistance have already been made by Messrs. Lever Brothers and Unilever, Ltd., Rolls Royce, Ltd., and the National Oil Refineries, Ltd., and it is anticipated that the scheme will be in operation for the summer of 1949.

Management Abstracts

FOR these days, *Management Abstracts*, the first issue of a series of specialized publications dealing with the different aspects of management to be published by the British Institute of Management (London), seems rather a lavish production. It covers some two hundred British and Overseas publications dealing with current developments in management science, and the abstracts are classified under such headings as general management and organisation; works management; personnel and welfare; financial management; distribution; supplies; transport; statistics; public administration; education and training. *Management Abstracts* will be issued monthly and is intended to cover, eventually, material published in any part of the world; but on its present scale such cover can scarcely be obtained without very considerable expansion on the first two issues. The basis of selection of the abstracts is not apparent, although the more important articles published in Great Britain in recent months appear to be included. For the annual subscription of 30*s*. (or 3*s*. per copy) the business executive may, as it is claimed, save some time; but the production is unlikely to give him much that he cannot readily obtain, and probably earlier, from an efficient firm's library. The publication also includes "Book Notes", which are brief and mainly descriptive. This section might perhaps be expanded with advantage and the length of the abstracts curtailed, particularly if the latter were made purely descriptive and not, as in these two issues, in part critical.

Milk: from Cow to Consumer

WALLACE PRODUCTIONS, LTD., have just finished making a documentary film for the United Dairies, Ltd. This film, which lasts for about half an hour, is called "The Milky Way" and was shown to a small invited audience on November 30 at the British Council Theatre in London. It tells the story of the production, pasteurization and distribution of milk under modern conditions with particular reference to London (the United Dairies, Ltd., being one of the major suppliers of milk in the London area); but the theme is representative of any large town or city where rigid precautions are taken with regard to the safety and purity of milk. The general scientific level of the film has been designed for showing to student-nurses and the senior science forms of secondary schools; but it can be recommended to any intelligent person, scientific or otherwise. The emphasis stressed throughout is on hygiene; but the full account of milk from cow to consumer is amply and well told. The makers and sponsors of this documentary film are to be congratulated on a production which has entertainment value as well as scientific and educational interest.

Information Services Committee

ARISING out of the Scientific Information Conference held last June, the Council of the Royal Society has set up a Standing Committee on Information Services. The terms of reference are: (1) to advise on means of improving existing methods of publishing, abstracting, indexing and distributing scientific information and, in particular, to advise on the implementation of the recommendations of the Royal Society Scientific Information Conference; (2) to report to the Council of the Royal Society.

The following have agreed to serve on the committee: Sir Alfred Egerton (*chairman*); the Treasurer and the Secretaries of the Royal Society; Dr. T. E. Allibone; Prof. J. D. Bernal; Dr. G. L. Brown; Sir David Chadwick; Mr. J. E. Cummins; Dr. G. M. Findlay; Dr. J. E. Holmstrom; Dr. A. King; Dr. J. G. Malloch; and Dr. C. F. A. Pantin.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: J. S. Campbell, agricultural officer, Nigeria; W. Galley, agricultural officer, Uganda; W. Smith, agricultural officer, Gold Coast; E. A. Edmonds, geologist, Gold Coast; N. J. Guest, geologist, Tanganyika; K. Taylor, geologist, Uganda; R. B. Smith, agricultural officer, Trinidad; J. H. Wheelan, assistant conservator of forests, Gold Coast; J. D. Farquhar (assistant conservator of forests, Palestine), assistant conservator of forests, Tanganyika; R. B. McConnell (geologist, Tanganyika), senior geologist, Nigeria. The following have been appointed assistant conservators of forests in the countries mentioned: M. F. H. Abraham (Kenya), M. C. Argyle (Kenya), J. H. Blower (Tanganyika), W. Carmichael (Tanganyika), D. M. Duggie (Gold Coast), W. G. Dyson (Kenya), C. A. Walker (Nigeria), F. Weston (Uganda).

Lectures on Manufactured Foods

THE Nutrition Panel of the Food Group of the Society of Chemical Industry is arranging a series of meetings for discussing the problems affecting manufactured foods in Great Britain. Sausages, soups, ice-creams, cake mixtures, jam, processed cheeses, and the like, form an important part of present-day dietary; but there is still much to be learned about their nutritional significance. The first meeting of this series will be held on Wednesday, January 5, 1949, at Gas Industry House, 1 Grosvenor Place, London, S.W.1, at 6.30 p.m., and the subject will be "The Sausage as Food". The speakers will include Mr. H. P. Blunt, of the Ministry of Food, on "The History of Sausages"; Mr. Osman Jones and Mr. M. G. Read, on the composition of fresh and processed sausages respectively; and Dr. Magnus Pyke on "Sausages and Nutrition".

University of Glasgow

PROF. C. M. YONGE has been re-appointed a director of the Scottish Marine Biological Association. Dr. Angus Macphail has been appointed lecturer in public health, and Dr. W. G. A. Begg an assistant in anatomy. Mr. John Green has resigned from the Departments of Biochemistry and Medicine to become lecturer in clinical chemistry in the University of Aberdeen, and Dr. J. D. Morrison from the Department of Chemistry to take up a post with the Council for Scientific and Industrial Research at Melbourne. Mr. J. C. Gunn, of the Department of Mathematics, University College, London, has been appointed to the Cargill chair of natural philosophy in succession to Prof. T. Alty.

For the current session 266 students have been admitted into the Faculty of Pure Science. Some 144 research students have been registered, including fifty working in the Royal Technical College, nine at the Hannah Institute and three at the Agricultural College.

Announcements

THE Medal of the Royal Society of New South Wales has been awarded to Prof. W. L. Waterhouse, research professor of plant pathology and agricultural botany in the University of Sydney. The award is made for meritorious contributions to the advancement of science: this may include administration and organisation of scientific endeavour. The citation states that this year's award is made to Prof. Waterhouse in recognition of his services to the Society and his valuable contributions to the field of agricultural science, particularly with regard to research on cereals.

PROF. R. E. MORTIMER WHEELER, professor of archæology in the University of London, formerly director-general of archæology in India, will serve as adviser to the Government of Pakistan in setting up a department for the exploration and preservation of ancient sites and in forming a museum at Karachi.

PROF. LINDSAY TASMAN RIDE has been appointed vice-chancellor of the University of Hong Kong. As an Australian Rhodes Scholar he graduated in medicine at Oxford, and has been professor of physiology at the University of Hong Kong since 1928. Prof. Ride had an active military career in China during the Second World War, since when he has been in command of the Hong Kong Volunteer Defence Force.

DR. E. J. BOORMAN has been appointed chief chemist of the Anglo-American Oil Co., Ltd. After postgraduate research at the Imperial College of Science and Technology, London, Dr. Boorman entered the Department of the Government Chemist, where he was concerned with petroleum products. Soon after the end of the War he joined the staff of Esso Development Co., Ltd.

DR. ARTHUR J. BIRCH, of the Dyson Perrins Laboratory, Oxford, has been appointed Smithson research fellow of the Royal Society for four years from January 1, 1949. The fellowship is tenable at the University of Cambridge, where Dr. Birch will continue his researches in organic chemistry.

THE following appointments have been made in the University of London: Dr. B. J. Lloyd-Evans, to the Kennedy chair of mechanical engineering, tenable at University College; Dr. W. F. Jepson, to the University readership in applied entomology, tenable at the Imperial College of Science and Technology.

A PROOF copy of Prof. Geitler's revision of the Cyanophyceæ in the "Natürliche Pflanzenfamilien" (1 *b*, 1942), most of the copies of which were destroyed during the War, has been sent by the author to Prof. F. E. Fritsch (at the Botany School, Cambridge). It will be loaned for short periods to anyone who is interested on application to him.

THE Rationalist Press Association has arranged a course of six lectures under the general title of "Intuition and Reason" to be delivered by Dr. Maurice Burton. The lectures will be given each Monday during January 17–February 21, 1949, at the Alliance Hall, Palmer Street, Westminster, London. Tickets for the course cost 12*s*. (9*s*. for R.P.A. members), and may be obtained from the Rationalist Press Association, Ltd., 4–6 Johnson's Court, Fleet Street, London, E.C.4.

THE Institution of Naval Architects is offering the Martell Scholarship in Naval Architecture, to be held at one of the following institutions: Universities of Glasgow, Durham (King's College, Newcastle-on-Tyne), or Liverpool, or the Royal Naval College, Greenwich. It is tenable for three or four years and of annual value £175. It is open to British apprentices or pupils, less than twenty-three years old, in the royal dockyards or private shipyards. Entries close on January 15; full particulars can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Method for Obtaining Wool Roots for Histochemical Examination

A USEFUL technique has been developed for obtaining moderately large samples of wool roots for histochemical examination. It is hoped that this technique will assist in elucidating the mode of formation of the wool fibre and also facilitate investigations already in progress in this laboratory, which are concerned with developing methods for removal of wool from sheepskins.

Fig. 1

Fig. 2

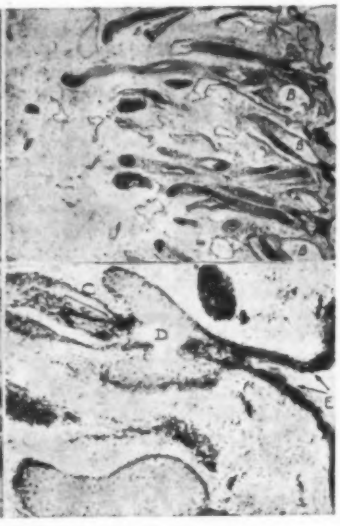

Fig. 3

Fig. 4

Formerly, it was possible, by tedious dissection of pulled staples of wool, to obtain a few milligrams of wool roots: by the new method 0·5–1·0 gm. can be collected with little effort.

A piece of sheepskin approximately 500 sq. cm. is cut from a fresh skin, most of the wool removed with scissors, and the remainder clipped to within 2–3 mm. of the skin. The skin is then placed flat, with flesh side down, on a piece of plate-glass. A beeswax–rosin mixture (2 : 7 by weight) at about 60° C. is then run over the surface of the skin to a thickness of about 5 mm. When the wax has set, it is lifted with the adhering skin from the glass and the skin peeled away from it gradually, leaving a wax sheet with the wool fibres firmly embedded in it and with the roots exposed. The roots can be harvested readily by clipping with an electric razor, or preferably with a fine animal-hair clipper. The clipping must be done carefully to avoid contamination with particles of wax. By this method it is possible to obtain material which is all of sub-epidermal origin.

To ascertain the nature of the tissue thus obtained, sections of the skin have been made before and after removal of the roots. The results of this examination are recorded in the accompanying photomicrographs.

A section of skin is shown in Fig. 1 with the wool roots intact and visible at points marked *A*. In Fig. 2 is seen a section of the same skin after removal of the fibres. Some tissue breakdown is evident; but the lining epithelium and the basal cells are for the most part intact. The vascular areas shown at *B* are probably artefacts and may be due to the removal of sudoriferous glands during sectioning. In Fig. 3 a complete root with shaft is seen *in situ*. The open area around the fibre is, no doubt, an artefact; but it does indicate that there is no strong attachment of the fibre to the follicle lining around the zone of keratinization. Fig. 4 shows the effect of removal of the root on the neighbouring structures. Derangement of the epithelium is evident at *C*; but, as shown at *D*, little or no sebaceous gland tissue has been removed, and the epidermis at *E* is intact.

The yield of roots from the wax sheets is affected by the depth of the root in the skin, and from measurements made on a number of different skins it was found that, whereas a root-length of 0·7–0·8 mm. yielded only 10–20 mgm. per 100 sq. cm. skin, a root length of 1·2–1·3 mm. yielded 200–300 mgm. per 100 sq. cm. skin. If the wool roots are too short for clipping, root extract can be obtained by applying a suitable extractant to the wax sheet and brushing it over the surface.

Roots have been obtained by the same technique from guinea pig skin, and no doubt the method is applicable to any type of skin.

Thanks are due to Miss H. M. Matthews for technical assistance.

WILLIAM J. ELLIS

Biochemistry Section,
Division of Industrial Chemistry,
Council for Scientific and Industrial Research,
Melbourne, Australia.
June 3.

Fine Structure of Cell Walls in Fresh Plant Tissues

THE increasing preoccupation of plant physiological laboratories throughout the world with problems of growth makes it very desirable that the details of structure in the cell wall, in growing tissue, should be known as completely as possible in the condition occurring in the living tissue itself. A good deal of the discussion arising from growth studies centres around the configuration of the cell wall, and the facile generalization of the striking results of X-ray analysis in dried material to cover the condition in fresh

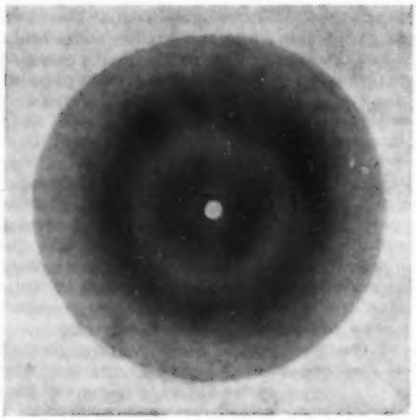

Fig. 1. X-ray diagram of a bundle of parallel filaments of *Rhizoclonium*, beam perpendicular to filament-length. The alga was put in the spectrometer straight from the culture vessel and kept running with water during the exposure. Exposure time 10·5 hr. Note that in addition to the two water haloes there is a diagram of cellulose identical with, though weaker than, that of the dried specimen in Fig. 2

tissue is perhaps not *a priori* legitimate; for it is highly improbable that the dried material, even when rewetted, can be considered with any exactitude as equivalent to the original material fresh from the plant. In point of fact, attention was directed some years ago to the implications of the fact that in bacterial cellulose the planes of 6·1 A.-spacing lie parallel to the surface of the cellulose plate only after drying[1], so that the demonstration of the special orientation of dried walls of *Valonia*[2] and *Cladophora*[3] did not necessarily guarantee a similar orientation in fresh material.

It should, however, be noted that the drying of bacterial cellulose might involve nothing more than a packing of flat plates (from the bacterial capsules) flat on the substrate, and the orientation might, in fact, be present in each plate even in the fresh cellulose.

More recently even the existence of crystalline regions in fresh material has been called into question[4]. It is observed that when fresh cotton hairs are photographed without drying, then the diagram shows merely the water haloes with no sign of a cellulose diagram; this latter appears only after the specimen has dried, but remains present on rewetting.

Correspondingly, Berkeley and Kerr regard the cellulose in cotton hairs as existing in the form of single, parallel cellulose chains separated by water molecules. It seemed to us that there were other, more probable, interpretations of these results. First, the water halo in fresh cotton is very intense and could possibly mask the cellulose diagram, the intensity of which might well be reduced by the absorption of X-rays by the water and by an angular dispersion of the crystalline regions caused by the presence of the water between them. Rewetting of dried specimens would not produce the same effects since it is well known that dried cellulose has a lower regain than fresh material, and in any event the lumina do not refill once the cells have dried.

We therefore decided to re-examine the condition of fresh material both for the existence of micelles and for special orientation, and therefore chose as our material an alga, *Rhizoclonium*, which will tolerate abundant water during the exposure in an X-ray spectrometer, and cambial tissue from *Pinus sylvestris* as an example of a rapidly growing tissue.

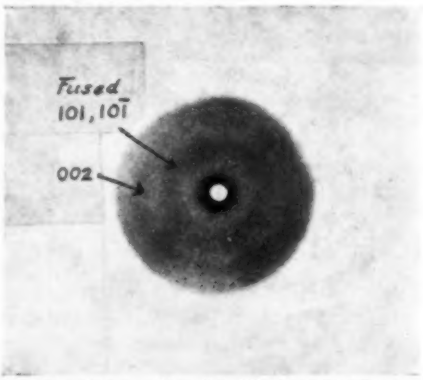

Fig. 3. X-ray diagram of a pellet of fresh cambial tissue maintained in equilibrium with air at 94 per cent relative humidity during the exposure. The 002 and fused 101 and 10$\bar{1}$ circles are clearly visible

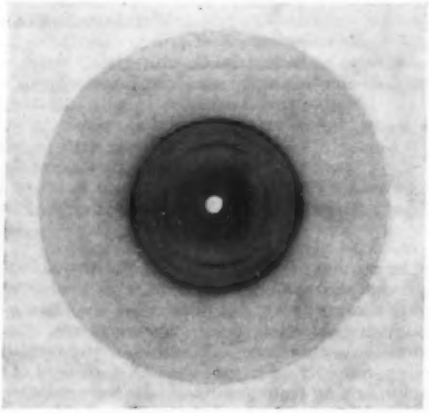

Fig. 2. The same bundle of filaments after drying. The photograph is much stronger but otherwise is identical with the cellulose diagram of Fig. 1

Both were collected fresh and kept wet during exposure, except that with cambial tissue the water halo had to be reduced in intensity by mounting the tissue in a holder within which the air was maintained at 98 per cent relative humidity. The tissues were then allowed to dry, and X-ray diagrams were taken of this dried material. The resulting photographs are presented in Figs. 1, 2, 3 and 4.

In comparing the two algal photographs it should be remembered that a reduction of apparent intensity in the cellulose diagram of wet material is to be expected both on account of the intense background and of the absorption of X-rays by water. Intensity differences can therefore at the moment be disregarded. In the wet specimen (Fig. 1) the arcs of the cellulose diagram are very apparent and are as sharp as those in the dry material. Further, the disposition of the arcs is the same, and in particular the 6·1 A.-arc is missing along the meridian. Thus in this material, which had never been dried, not only is the cellulose organised into micelles, but also these in turn have already the special orientation

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[None of the vacancies in these columns relates to a man between the ages of 18 and 50 inclusive, or a woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.]

SOUTHERN RHODESIA
DEPARTMENT OF AGRICULTURE AND LANDS

Applications are invited for the following posts in the Pasture Research Division, from applicants possessing a specialized four-year degree of a recognized university. Post-graduate training and experience in pasture research will be taken into consideration. In regard to the senior post, only applicants who provide satisfactory proof of ability to carry out research of a high order will be considered for appointment.

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(b) Research Officers (three): on the scale £495 × £27 10s.–£660 × £77–£737 × £33–£935 per annum.

The duties of one post will largely be concerned with botanical surveys in connection with pasture problems.

Commencing salaries may be higher than the minimum according to the qualifications and experience of the officers appointed, but subject to a maximum of four steps in scale (b). In addition, a cost-of-living allowance (on a graduated scale of between £86 to £150 per annum) is at present payable, as well as children's and marriage allowances as governed by the Civil Service Regulations of Southern Rhodesia.

Applications, in writing, stating nationality, age, marital condition, qualifications, experience, together with copies of testimonials and published scientific papers (if available), should reach the Secretary to the High Commissioner for Southern Rhodesia, Rhodesia House, 429, Strand, London, W.C.2, not later than December 31, 1948.

BELFAST EDUCATION COMMITTEE
COLLEGE OF TECHNOLOGY
Belfast

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CHEMISTRY AND PHARMACY DEPARTMENT

Applications are invited for the following positions in the Chemistry and Pharmacy Department of the College of Technology, Belfast:

(a) Teacher of Chemistry, with special reference to inorganic chemistry.

(b) Teacher of Pharmaceutics.

It is desirable in each case that the person appointed should hold a good honours degree.

The salary in each case will be in accordance with the scales laid down by the Ministry of Education for Northern Ireland, which, depending on qualifications, provide in the case of graduates for salaries of £315, rising by annual increments to £630 per annum, or £350, rising by annual increments to £700 per annum.

In fixing the commencing point on the scale, allowance will be made for previous teaching and industrial experience; in the latter case up to a maximum of ten years.

Further particulars and forms of application for these positions may be obtained from the Principal, College of Technology, Belfast, with whom applications must be lodged as soon as possible after the date of appearance of this advertisement.

J. STUART HAWNT,
Director of Education.

Education Office,
Belfast.

AUSTRALIAN LEATHER RESEARCH ASSOCIATION
APPOINTMENT OF DIRECTOR OF RESEARCH

Applications are invited for the appointment of Director of Research of the Australian Leather Research Association, a Research Association aided by the Australian Council for Scientific and Industrial Research. The laboratories are at present situated in Sydney, New South Wales.

Applicants should possess a university degree or other appropriate qualification, and preferably, a knowledge of leather technology.

He is also required to have a practical outlook, and those qualities fitting him for leadership and the direction of a research staff.

The appointment will be in the first instance for three years, and the salary is of the order of £1,500 (Australian) per annum. Travelling expenses to Australia will be arranged.

Applications, as complete as possible in detail, should be addressed to A. Harvey, F.R.I.C., "Craigieburn," Duppas Hill Road, Croydon, Surrey.

HIS MAJESTY'S COLONIAL SERVICE

There is a vacancy in the East African Tsetse Reclamation Department, Kenya, for a botanist. Minimum academical qualification required is a second-class honours degree in natural science with at least one year's training in botany, and the post is on contract and carries a salary in the scale £585, £585, £655 × £35–£760, £830 × £35–£1,005 × £45–£1,320. Income tax is at local rates, and if Government quarters are provided, rental is charged at 10 per cent of salary, up to a maximum of £150. Free passages are provided for officer and wife, on appointment and when proceeding on leave; and if they have children, the cost of one additional adult passage, or the actual cost of the children's passages, whichever is less, is also provided. An outfit allowance will be paid on appointment.

Duties will include a good deal of safari work in Kenya, Tanganyika and Uganda, identifying and summarizing tree and shrub vegetation in the areas where field experiments are being carried out. The officer will also be expected to take a close interest in entomology, and to study the relationship of vegetational cover to the tsetse fly.

Application forms may be obtained from the Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, S.W.1.

BETHLEM ROYAL HOSPITAL AND THE MAUDSLEY HOSPITAL
Denmark Hill, S.E.5

(with which is associated the Institute of Psychiatry)

Applications are invited for the whole-time post of Assistant Neuropathologist. The post will be subject to a probationary period of one year, and will be associated with a corresponding appointment on the staff of the Institute of Psychiatry. The main duties will consist of research into the structural pathology of mental disease to be carried out under the direction of the Head of the Department of Neuropathology in the Research Laboratory in close conjunction with the Biochemical Department. Medical graduates with relevant experience in neuroanatomy, neuropathology or psychiatry, and non-medical graduates in the relevant biological sciences will be considered. The salary will be on a scale within the range of £750 to £1,220 a year, and will be fixed with due regard to the qualifications and experience of the successful candidate.

Applications, containing curriculum vitae, and giving the names of three referees, should be sent to the undersigned, within three weeks after the date of appearance of this advertisement. Canvassing of members of the Board of Governors will lead to disqualification.

K. J. JOHNSON,
House Governor.

WOOLWICH POLYTECHNIC
Woolwich, S.E.18

The Governing Body invite applications for the post of Lecturer in the Electrical Engineering Department. The work of the department includes the preparation of students for the Internal B.Sc. (Eng.) degree of the University of London, for the ordinary and higher national certificates, endorsement of the higher national certificate and similar courses. Applicants should hold a degree (in electrical engineering) of a *British university*.

Experience in the design and performance of electrical machinery and/or teaching experience, while not essential, would be additional qualifications.

Commencing salary, which is in accordance with the Scales of Salary of Teachers in Technical Colleges, would be between £336 and £708 per annum and depends on age, qualifications, experience and training.

Full particulars of this post and an application form may be obtained from the Clerk to the Governors, to whom the forms should be returned within two weeks from the date of this advertisement.

READING AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE
ROYAL BERKSHIRE HOSPITAL
Reading

Physicist required for Radiotherapy Department. Qualifications, honours B.Sc. Previous experience in radiotherapy essential. Salary £700 × £50–£1,150 per annum, according to experience. Superannuation scheme in force.

Applications, together with copies of two recent testimonials, to be sent to the Administrative Officer, Royal Berkshire Hospital, Reading, marked "Appointment of Physicist."

HIS MAJESTY'S COLONIAL SERVICE

There are two vacancies in the Department of Agriculture in Kenya, for Entomologists, one of which may be filled by a woman candidate.

Applicants must possess a degree in a biological subject, or in agriculture with specialized training in entomology, and at least one year's post-graduate work in economic entomology. Candidates over the age of 35 can only be considered for appointment on contract. The posts may be taken up either on a permanent and pensionable basis, or on contract, and carry salaries of £585, £585, £655 × £35–£760, £830 × £35–£1,005 × £45–£1,320 for men, and £468, £468, £524 × £28–£608, £664 × £28–£804 × £36–£1,056 for women. Free passages will be provided on appointment and on leave for each officer, his wife, and children up to the maximum cost of three adult passages. If Government quarters are provided a rental of 10 per cent of salary is deducted from salary, and if the officer occupies private quarters he may claim an allowance equal to the amount by which the rent exceeds 10 per cent of his salary. Allowance for considerable experience may be made in determining initial salary. Duties will include laboratory and field research, control of insect pests, advisory work on agricultural entomology and the administration of plant import regulations.

Application forms may be obtained from the Director of Recruitment (Colonial Service), Colonial Office, S.W.1.

HIS MAJESTY'S COLONIAL SERVICE

There are vacancies for three Soil Survey Officers in the Gold Coast to supervise the collection of information about the soils of the forest region in that territory. The selected candidates will be required to act as assistants in the carrying out of a soil survey by a method already established and to assist in the preparation of maps showing the distribution of soils. The work will be mainly in the field and the officers will be required to spend a good deal of time under canvas and should have a definite field outlook. The qualifications required are at least a second-class honours degree in natural science or geography and preference will be given to candidates with special qualifications in plant ecology. Post-graduate experience is not essential.

The appointment will be either permanent and pensionable or on contract and will carry a salary in the scale of £450 (for five years), £510 × £30–£660, £720 × £30–£960 × £40–£1,000. In addition overseas pay is paid at a rate varying between £150 and £300.

The initial salary will be based on previous experience and war service. Free first-class passages are provided for the officer and his wife on appointment and on leave. Income tax is payable at local rates. Candidates should have been born on or after January 1, 1908.

Application forms may be obtained from the Director of Recruitment (Colonial Service), Colonial Office, S.W.1.

H.M. DOCKYARD SCHOOLS
ASSISTANT MASTERS

Civil Service Commission. Applications are invited for permanent appointments as Assistant Masters in the above schools for service beginning on January 10, 1949, or as soon after as possible. Candidates, who must have been born on or after August 2, 1909, must possess an honours degree or have equivalent qualifications. There will be three vacancies for persons with qualifications in mathematics, physics, and engineering (electrical or mechanical) respectively. Salary in accordance with the Burnham Scale for Technical Colleges. Appointments are pensionable under the Civil Service Superannuation Act on a non-contributory basis.

Further particulars and application forms can be obtained from the Director (P.A.), Education Department, Admiralty, S.W.1, to whom the application forms should be returned, not later than January 1, 1949.

CHESTER BEATTY RESEARCH INSTITUTE
ROYAL CANCER HOSPITAL

Physical Chemist required to take part in an investigation of tissue proteins and related problems, using physical methods including ultra-centrifugation and electrophoresis. Applicants should hold a higher degree and have appropriate research experience. Direct acquaintance with the protein field a recommendation, but is not essential. Salary according to age and qualifications.

Applications to be sent by the first post on Tuesday, January 11, to the House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.

FOUAD I UNIVERSITY

Faculty of Science

PROFESSOR OF ASTRONOMY

Applications are invited for the post of Professor of Astronomy.

The appointment will be on contract for an initial period of two years with salary £E1,500 (equivalent to about £1,537) from which a tax of 6 per cent will be deducted.

Travelling expenses to Cairo will be paid to the appointed candidate.

Applicants should submit particulars of their qualifications and experience in teaching and research to the Dean, Faculty of Science, Fouad I University, Abbassia, Cairo, Egypt.

The closing date for receipt of applications will be January 15, 1949.

THE POLYTECHNIC

309, Regent Street, W.1.

A post-graduate course of Lectures on Electronics will be held on Thursday evenings from 7 to 8.30. The last two parts of the course are: (C) January 13 to February 17, 1949, "Electron-Optics," by W. Ehrenberg, Ph.D., F.Inst.P. (Birkbeck College, University of London).

(D) February 24 to March 31, 1949, "The Electron Microscope," by F. W. Cuckow, M.Sc., F.Inst.P. (Chester Beatty Research Institute, Royal Cancer Hospital, London).

The fee for each of these parts will be 12s. 6d.

A detailed syllabus of the lectures is available. Application to attend Parts C and D should be made as soon as possible to the Head of the Department of Mathematics and Physics, The Polytechnic, Regent Street, W.1.

READING AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

ROYAL BERKSHIRE HOSPITAL

Reading

Applications are invited for the post of Biochemist to the Reading Group of Hospitals.

Applicants must be university graduates, but not necessarily medically qualified, and should have had experience of hospital biochemistry.

Salary will be according to qualifications and experience on a scale £800–£1,000 per annum.

Applications to be submitted to the Administrative Officer, Royal Berkshire Hospital, Reading, marked "Appointment of Biochemist".

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Applications are invited for a post as Senior Lecturer or Lecturer in Anatomy.

Salary scales: Senior Lecturers, £750, rising by £50 every two years to £1,000. Lecturers, £550, rising by £25 every year to £650; if the appointment is then renewed, £700, rising by £50 every two years to £800, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance. The commencing salary on either scale will depend upon the qualifications of the successful candidate, who will be expected to enter upon his duties on June 1, 1949.

Applications (four copies), with the names and addresses of three referees, and, if desired, copies of three recent testimonials, should reach the undersigned (from whom further particulars may be obtained) by January 22, 1949.

A. W. CHAPMAN,
Registrar.

GOVERNMENT OF IRAQ

Applications from qualified candidates are invited for the following post:

Cerealist required by the Government of Iraq for the Directorate-General of Agriculture for three years on contract. Salary, Iraq Dinars 1,800 a year, plus high-cost-of-living allowance, I.D. 288 a year. (Iraq Dinar 1 = £1.) Provident Fund. Free first-class passages and liberal leave on full salary. Candidates should possess a university degree and have had special experience in plant breeding.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/18187/3C on both letter and envelope.

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(UNIVERSITY OF READING)

Physicist, about 30 years of age, first- or second-class hons. degree in physics and preferably some years' research experience, required to investigate physical properties of dairy products, especially liquid milk. The post is of the Senior Scientific Officer Grade (salary £670 × £25–£860 consolidated), and the starting point within the grade will depend on experience and qualifications. Apply to the Secretary, N.I.R.D., Shinfield, Reading.

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Further particulars may be obtained from the Deputy Registrar, City and Guilds College, Exhibition Road, S.W.7.

BRITISH SCHERING RESEARCH INSTITUTE

CHIEF RESEARCH CHEMIST

Owing to the appointment of the last holder to a senior academic post, applications are invited for the position of Chief Chemist to act as leader of a team. Applicants must possess high academic qualifications and experience in synthetic organic medicinals, as well as experience as a leader. Salary will depend also on evidence of initiative, industry and personality. Full details and testimonials to the Director, Brook Lane, Alderley Edge, Cheshire.

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SCIENTISTS WITH UNIVERSITY QUALIfications in one or more of the subjects of physics, chemistry, zoology, engineering, botany, agriculture, physiology and hygiene, are required as assistants to the Director, Science, Festival of Britain, 1951. They will be primarily responsible for the representation of Science in the Festival Exhibitions and other activities and must have ability for accurately interpreting technical material into readily understandable language. There is much scope for originality in devising new methods of presentation. Salaries, £850–£1,000 or £1,000 to £1,200 in accordance with qualifications. The posts are tenable for about three years and are based on London.

Write, quoting A.321/48/A to Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application forms, which must be returned completed by December 31, 1948.

ENGINEER II (UNESTABLISHED) required at Research and Development Establishment, Ministry of Supply. Applicants must be of British nationality, born of British parents (copy of detailed regulations on application to Ministry of Supply, Room 432, Adelphi, John Adam Street, Strand, London, W.C.2), and should have served an engineering apprenticeship and hold corporate membership of Institution of Civil, Mechanical or Electrical Engineers, or have passed examinations recognized as granting exemption from Sections A and B of their Associate Membership Examinations, and have thorough knowledge and experience of use of field explosives by the Services. Applicants having exceptional experience of this class of work without possessing full stated qualifications would be considered. Duties.—To take charge of experimental work in testing explosives and demolition equipment, to develop equipments and techniques for demolition of structures and be responsible for all safety measures in connection with the work. Salary.—Range £720–£960 per annum.

Write, quoting order number E569/48, to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application form, which must be returned completed by January 7, 1949.

APPLICATIONS INVITED IN RESPECT OF an immediate vacancy for Research Fellowship of about £250 p.a. in department of chemical engineering and applied chemistry. The work will involve determination of physical properties of oil mists and will be of character required for higher degree. Applicants should, in general, have obtained honours degree in chemistry, physics or mechanical or chemical engineering. Agreement provides for work to continue until March 31, 1950, but extension of period may be granted. Applications to Secretary, Imperial College, London, S.W.7, not later than January 1, 1949.

CHEMISTS AND CHEMICAL ENGINeers required for service at home and abroad with large petroleum organization. Vacancies exist for Research and Works Chemists. Previous industrial experience not essential but candidates must possess first- or second-class honours degree, or equivalent, and be under 30 years of age. Salary according to age, qualifications and experience, with a minimum of £400 per annum. Please write details of age, qualifications, experience and when available, to Box PC.574, Deacon's Advertising, 36, Leadenhall Street, E.C.3.

IMPERIAL CHEMICAL INDUSTRIES Limited, Dyestuffs Division, require a Laboratory Technician with biological interests to assist in research on the chemotherapy of cancer. Previous laboratory experience essential. Intermediate B.Sc. or equivalent desirable. Applicants should be under age 30 years. Written applications to Staff Department, Hexagon House, Blackley, Manchester, 9.

THE BRITISH RAYON RESEARCH ASSOciation has a vacancy for a Physicist, preferably with some research experience, to study rheological properties of yarns and filaments. Age: 20's to 30's. Commencing salary will be dependent on age and experience, in accordance with the scale laid down for scientific personnel on Government service. All appointments carry superannuation under the F.S.S.U. Apply to the Secretary The British Rayon Research Association, Bridgewater House, 58, Whitworth Street, Manchester, 1.

SENIOR COLOURIST REQUIRED BY LARGE dyestuff manufacturers. The applicant must have wide knowledge of the colour-using industries and good organizing ability. Excellent executive situation carrying high salary and good prospects. Reply in first instance, with full particulars, to "Colourist," c/o Messrs. Addleshaw, Sons & Latham, Solicitors, 15, Norfolk Street, Manchester, 2.

ALBRIGHT & WILSON REQUIRE A Technical Assistant to work in London on the development of new products and new uses for existing chemicals. Applicants should have a degree in chemistry, preferably some industrial experience. Age 25–32. Apply to Albright & Wilson, Ltd. (Development Dept.), 49, Park Lane, London, W.1.

A LARGE AND LONG-ESTABLISHED industrial research laboratory has vacancies for Physicists and Electrical Engineers to extend research and development work in connection with ultra high-frequency valves, gasfilled devices and circuits. Openings are available both for senior workers with research experience and for those direct from degree courses. Applications can be made now for immediately available posts, or for future vacancies. Those interested are invited to send full particulars, and suitable candidates will be invited to visit the laboratory. The posts are pensionable and appropriate publication of work is encouraged. Apply Box No. 490, T. & G., 101, St. Martin's Lane, London, W.C.2.

RESEARCH ASSISTANT IN GLASGOW for mechanical engineering problems, both fundamental and development. Honours degree in mechanical engineering or physics, together with experience in one or more of heat transfer, centrifugal pumps, aerodynamics. Reply in own handwriting, stating qualifications, age, salary required, etc. Box 376, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

A VACANCY EXISTS IN THE CENTRAL Research and Development Department of the Distillers Company, Limited, for a Physical Chemist to take charge of a small section engaged on the development of textile fibres from synthetic polymers. Previous experience is essential. Applicants must possess first- or second-class honours B.Sc. degree and should be between 25 and 35 years of age. The appointment will be tenable, in the first instance, at Epsom, Surrey. Applications should be submitted to the Controller of Research and Development, The Distillers Company Ltd., 21, St. James's Square, London, S.W.1.

(*Continued on page cclv*)

CAMBRIDGE STANDARD CELLS

Details are given in SHEET 256-N. May we send a copy ?

These Cells are constructed on the principles suggested by Sir F. E. Smith, F.R.S. Their reliable characteristics are shown by the following results of recent tests by the National Physical Laboratory on nine cells.

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	15·0° C.	20·0° C.	25·0° C.
1	1·0187$_7$	1·0186$_0$	1·0183$_3$
2	1·0187$_8$	1·0186$_0$	1·0183$_3$
3	1·0187$_7$	1·0185$_9$	1·0183$_3$
4	1·0187$_7$	1·0185$_9$	1·0183$_7$
5	1·0187$_7$	1·0185$_9$	1·0183$_7$
6	1·0187$_7$	1·0185$_9$	1·0183$_7$
7	1·0187$_7$	1·0186$_0$	1·0183$_3$
8	1·0187$_8$	1·0186$_0$	1·0183$_3$
9	1·0187$_8$	1·0186$_1$	1·0183$_8$

*As now employed instead of the old "international" volt.

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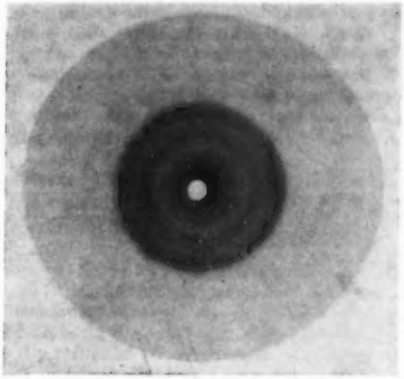

Fig. 4. Comparable photographs of a pellet of dried cambium

demonstrated in dried cells. In cambium, too (Fig. 3), the 3·9 A.-ring and the fused 5·4 and 6·1 can plainly be identified so that here, too, micelles exist in fresh tissue, much as they do in dry material (Fig. 4). In point of fact, it is probable that the 6·1 A. (101) arc is missing in untreated cambium. This point will be discussed elsewhere; it is not of importance to the present discussion, and the inner ring in the cambium diagrams is therefore treated conventionally as a fused 101, 10$\bar{1}$. It is not, of course, clear that the size of the micelles is the same in wet as in dried tissue; but it is certain that in the materials we have used, crystalline regions do exist sufficiently extensive to give rise to X-ray diagrams.

It is therefore reasonably certain that consideration of growth processes in plant cells will need to continue to be made in terms of wall structure substantially similar to that described for dried material.

The senior author is indebted to the Department of Scientific and Industrial Research for a grant to cover in part the expenses of the algal research, from the programme of which some of the present results are drawn.

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Extraction of Bright Coals by Anhydrous Ethylene Diamine

Pyridine has long been known as a good solvent for coal[1]. It is effective even at room temperature, and causes marked swelling of the coal substance. Solutions are usually prepared at the boiling point and are recognized to be at least predominantly colloidal. It has recently been found that ethylene diamine is a more rapid and in some respects more powerful solvent, its action being similar in many ways to that of pyridine. A preliminary survey has been made of its interaction with coals. As with pyridine[2], the action of ethylene diamine is retarded by the presence of moisture; commercial diamine containing 40 per cent water has very little effect at room temperature. The solvent used in this work contained less than 1 per cent water.

The process of solution of lower-rank bituminous coals is accompanied by great swelling of the solid and a large heat evolution. Dried pieces of whatever size imbibe finally about 1·2 gm. of diamine per gm. of coal. Irreversible adsorption of the solvent is observed on both residue and recovered extract; when, by a nitrogen balance, allowance is made for this, the total yield of solid products agrees closely with the weight of original coal. The extract solutions have been studied by optical and other methods and found to consist largely of colloidal particles of the order of hundreds of angströms in diameter, together with a background of somewhat smaller material (I am indebted to Dr. L. Kann of these laboratories for this information). The evidence to date does not preclude the presence of small molecules in addition; but the quantity in this form is certainly not great. Osmotic measurements (for example, vapour-pressure lowering) are unreliable because a very small quantity of ammonia is slowly but continuously evolved by coal in contact with ethylene diamine. (The source of the ammonia has not been established; in view of the small quantity produced, and the readiness with which ethylene diamine liberates ammonia on treatment with other substances, its formation may be adventitious.) In many cases, unlike the behaviour of pyridine-coal sols, the solution of extract in the original solvent continues to form a stable colloidal solution when poured into water, although it can readily be flocculated by addition of acid or of multivalent cations. The particles in aqueous solution (at pH $\sim$ 11·5) are negatively charged.

Higher rank (coking and steam) coals yield very much less extract than those of lower rank and show a much smaller degree of swelling. After 48 hours treatment in a Soxhlet apparatus containing nitrogen at atmospheric pressure, typical yields of extract, corrected for solvent, are: coals containing less than 85 per cent carbon (Parr pure coal basis), 35–40 per cent; coals containing more than 88 per cent carbon, 1–5 per cent. Anthracite is not visibly affected and yields no extract. Bovey Tracey lignite yields, in a Soxhlet apparatus, about the same proportion of extract as a low-rank bituminous coal; at room temperature the yield of extract is relatively smaller, though the swelling is much the same as with the coal. 'Humic acids' produced by oxidation of coal and purified by extraction with, and re-precipitation from, an organic solvent dissolve only to a limited extent in ethylene diamine even at the boiling point; on addition of water, however, they dissolve rapidly and completely just as in 10 per cent aqueous sodium hydroxide. Irish dopplerite swells considerably but very slowly in ethylene diamine, and very little extraction (as indicated by colour) takes place even on boiling; it is rather more soluble when water is added. The same sample of dopplerite was only slightly soluble in 10 per cent sodium hydroxide. Spruce lignin (for which I am indebted to Dr. W. G. Campbell, of the Forest Products Research Laboratory, Princes Risborough) and cellulose both swell in ethylene diamine, but yield no appreciable soluble material.

The degree of extraction at room temperature varies in an interesting manner with solvent/coal ratio, successive treatment of the same material, and

coal rank. This will form the subject of a further communication. It may be mentioned here, however, that at room temperature the degree of extraction of low-rank coals rapidly approaches a limit (about 10 per cent) as the solvent/coal ratio is increased; if the sol is then removed by filtration and fresh solvent is added, a further substantial amount of extract (about 5 per cent) is obtained. This can be repeated many times before the amount of extract becomes negligible.

It is now well recognized that coal has a colloidal structure[3]. The type of extraction phenomenon outlined in the last paragraph is characteristic of colloidal systems, although the present case appears to have some unusual features. Swelling in solvents is a normal property of colloidal substances, including polymers. In the case of coal, a thermodynamic treatment must take into account the distribution of colloidal material in appreciable concentration between both phases.

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Properties of Ethylene Diamine

The properties of ethylene diamine have been summarized by Wilson[1] and by Putnam and Kobe[2]. In the course of recent work with this substance, additional and in part contradictory information has been obtained.

Samples of commercial anhydrous ethylene diamine were refluxed with metallic potassium until the liquid became permanently dark-coloured; it was then distilled, and redistilled to check the boiling point. At 20° C. the viscosity was found to be 1·52 cp., the density 0·893 gm./c.c. These values are rather lower than previous determinations. The kinematic viscosity is very sensitive to small quantities of water and of carbon dioxide, and its measurement has been found convenient as a rapid test for purity. A striking maximum (~ 12·7 cp.) occurs in the curve relating dynamic viscosity to water content, at a molecular proportion of approximately 1 diamine : 2 water. The refractive index is not sensibly altered by addition of up to 3 per cent by weight of water. It has also been found that the point of half-neutralization in the potentiometric titration curve can readily be detected, but is not sharp enough to be used for the accurate analysis of ethylene diamine–ammonia mixtures.

The anhydrous diamine is miscible in all proportions not only with water, but also with lower alcohols, ethers and ketones, chloro-methanes and lower benzene homologues. Addition of 2–4 per cent of water by volume has been found to effect sensibly complete separation of ethylene diamine from solution in such liquids as xylene and ether; it is probable that earlier reports of its limited solubility in some of the above solvents have arisen from the use of insufficiently dried diamine.

Diamine is immiscible with paraffins unless a third component, such as alcohol or chloroform, is added.

So far as we are aware, the unpleasant temporary physiological discomforts which can be caused by ethylene diamine are not well known. The liquid if not washed from the skin causes blistering. One of the authors appears to be allergic to the fumes even in low concentration. The symptoms (acute fits of coughing some hours after exposure) did not in the first instance develop for some weeks.

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[1] Wilson, A. L., *Ind. Eng. Chem.*, **27**, 867 (1935).
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Solubility of Bituminous Coal in Alcoholic Potash

In the course of some exploratory experiments carried out eighteen months ago when I was a member of the staff of the British Coal Utilisation Research Association, it was observed that appreciable quantities of some bituminous coals were soluble (or dispersible) in alcoholic potash. A Northumberland coal containing 82·6 per cent of carbon and 5·1 per cent of hydrogen (on ash-free basis) was soluble to the extent of 20 per cent. Since its solubility in aqueous potash was quite inappreciable, this coal contained no significant quantity of ulmic material ('humic acids'), such as is formed when coal is oxidized by air exposure. Moreover, the proportion of coal extracted by alcoholic potash at the boiling temperature was unchanged when the experiment was carried out in the complete absence of air.

The extracted material remained dissolved (or dispersed) on diluting the alcoholic solution with water, but—like the so-called 'humic acids' obtained by the slow oxidation of coal—was immediately flocculated to a brown powder on addition of dilute acid. The elementary composition of this material was close to that of the parent coal (both being reduced to the pure coal basis), but it contained a somewhat higher proportion of oxygen (determined 'by difference').

The presence of small quantities of water in the alcohol (or the coal) slowed down the rate of extraction somewhat, but appeared to have but little influence on the proportion of extract finally obtained.

In further experiments the same parent coal was first separated into α-(pyridine-insoluble), β-(pyridine-soluble, chloroform-insoluble) and γ-(chloroform-soluble) fractions. The γ-fraction was found to be almost completely soluble in hot alcoholic potash, the β-fraction soluble to the extent of *c.* 50 per cent and a small portion of the α-fraction was also soluble. The extracts from all three fractions were similar in their behaviour.

A South Wales 'coking' coal (containing 89·7 per cent carbon and 5·0 per cent hydrogen on the ash-free basis) was soluble only to the extent of about 5 per cent in alcoholic potash. The extract showed similar behaviour to that from the Northumberland coal. While these experiments with only two coals afford insufficient data for generalization, a decreasing degree of solubility with increase of rank is for several reasons to be expected.

One possible interpretation of the behaviour described is that the alcoholic potash effects an ester

hydrolysis, and that part of the coal substance consists of 'humic humates'.

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Membrane Electrophoresis in Relation to Bioelectrical Polarization Effects

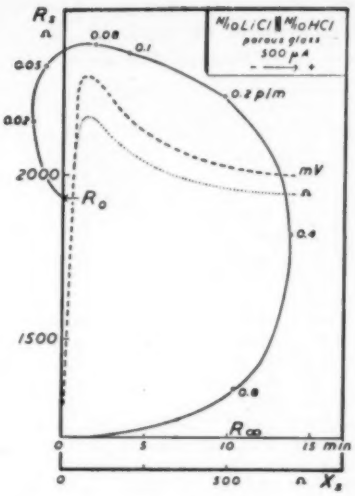
In electrophysiology the term 'polarization' often has an ambiguous meaning. Here it will be used in the physical sense as an overall definition to include changes in the 'resting potential' of the object (membrane, nerve, skin, etc.), as well as the appearance of rectification, capacity and inductivity effects under the influence of an externally applied current. The potential changes and the rectification effects have mostly been interpreted in a qualitative manner in terms of selective ion permeability, and the capacity as 'double layers', 'dielectrics', etc.[1,2,3]. Cole[4] has recently made the unexpected observation of an inductance component in the squid axon, which he seems inclined to explain as analogous to piezoelectric behaviour. Lorente de Nó[5] prefers more unspecific concepts implying also chemical reactions.

A very simple system, which can display the characteristic features of polarization, is:

Homogeneous mass (1)	Porous membrane	Homogeneous mass (2)
A^+R^-	$A^+R^- + B^+R^-$	B^+R^-

If the mobility of the ion constituent B^+ is greater than that of A^+, then the application of direct current, with the direction (1) anode and (2) cathode, will decrease the conductivity within the membrane. A reversed current direction will increase it; thus the 'rectification' may be easy enough to understand. The membrane behaves as a non-linear circuit element. Obviously this type of electrolyte system is closely related to the well-known 'moving boundary' systems. Theories[6–11] and experiments[12,13] show that the transition layer between masses (1) and (2) under appropriate conditions can be segregated in successive layers with different ionic compositions, which can *move* in either direction. These concepts can easily make understandable the fact that a membrane, supporting electrolytes, can change its longitudinal conductivity in a non-linear fashion. A great variety of patterns of the interrelations between direction, density and duration of the applied current and the resulting conductivity can be anticipated. The changes of the conductivity (and membrane potential proper) may lead to voltage *vs.* time curves similer to those known from the transient responses on rectangular D.C. pulses, applied to circuits containing resistances, capacities and inductivities.

The accompanying graph provides an example taken from a preliminary study. A system 0·1 *N* lithium chloride (stirred)/porous glass membrane/0·1 *N* hydrochloric acid (stirred) was subject to constant current flow with the cathode on the hydrochloric acid side. The change of the total membrane voltage with time exhibits an 'overshooting' (see the dashed curve, mV) well known from certain RLC (or RC) circuits. The parallel course of the high-frequency resistance of the membrane layer (dotted curve, Ω) indicates that the temporal variation of the potential is, in the main, caused by changes of the electrolyte content within the membrane (the membrane potential proper, that is, the 'back-E.M.F.',



plays a minor part here). The voltage-time curve has also been transformed into an A.C. 'impedance locus diagram' by the aid of 'square wave analysis'[14]. The locus curve (full line) of the impedance at different A.C. frequencies is of the shape regarded as typical for a resistance–capacitance–inductance circuit (cf. ref. 15).

In conclusion, it may be stated that a purely aqueous electrolyte system may exhibit effects formally similar to rectification, capacity and inductivity. Changes of the 'resting potential' or 'back E.M.F.' can also be demonstrated, especially with charged membranes. All phenomena are due to ionic redistributions within the membrane, initiated by the flowing current. These observations may have bearings on discussions on the nature of biological polarization phenomena. More experimentation under well-controlled conditions seems desirable. Theories of electrolytic migration also require extension to include the effects of diffusion, membrane dimension, membrane charge, solvent movement, etc. Investigations in these directions are being made in this laboratory.

This type of moving-boundary can obviously be utilized as an electrophoresis method for separation purposes, particularly if a superposed counter-flow of the solvent is employed.

An extended report of this work will be published elsewhere.

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Uppsala. Aug. 3.

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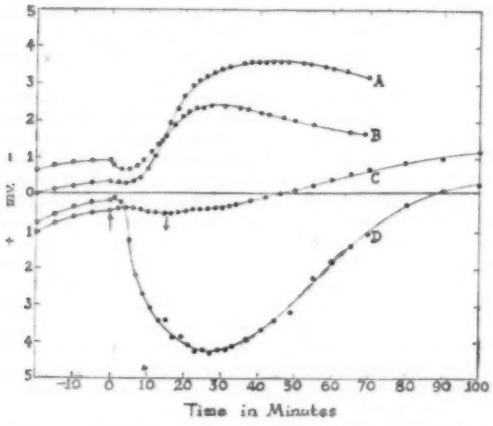
Electrical Potential Change Accompanying the Development of Rigor in Iodoacetate-Poisoned Muscle

No *a priori* answer can be given to the question whether the development of rigor in muscle poisoned by iodoacetate is accompanied by electrical depolarization, though it may be expected that the muscle after developing rigor will eventually become depolarized. The present work was an attempt to find an experimental answer to this question.

The sartorius muscle of the toad prepared with its nerve for stimulation was employed. The preparation was poisoned by soaking for 30–60 min. in 1/10,000–1/20,000 iodoacetate solution, sometimes with the addition of sodium cyanide to the concentration of *M*/1,000–2,000. Rigor of the poisoned muscle was induced in the usual way by stimulation, at the rate of one shock every 5 sec. in most experiments. A rough indication that the development of rigor was not accompanied by any considerable depolarization was first obtained by showing that the muscle, soon after the development of rigor, gave demarcation potential of the usual magnitude on crushing or on application of isotonic potassium chloride.



Time-course of electrical potential change of poisoned half of muscle relative to normal half. Stimulation, one shock every 5 sec. between arrows. See text for other explanation

A closer examination was then made by poisoning one half of the muscle and measuring the potential of this half against the normal half at short intervals during and after the onset of rigor. In such experiments the muscle was naturally mounted in air and the results regularly showed a slowly developing depolarization, beginning shortly after the start of stimulation and reaching a maximum in 30–40 min., roughly paralleling the course of the development of rigor. Both the course and the magnitude of the depolarization, however, depended on the temperature. The results of an experiment at 10–11° C. are reproduced in the accompanying graph, curves *A* and *B*, given by two symmetrical muscles. A comparison of pairs of curves such as these revealed the influence of an apparently insignificant difference in the experimental condition. When two strands of cotton-wool were used for connecting the muscle to the calomel half-cells used as leads (curve *A*), the depolarization was regularly greater than when two troughs about 8 mm. wide filled with Ringer solution served as contacts (curve *B*). The only obvious difference was that, if there was anything liberated by the muscle, it would be partially washed away from the segments of the muscle lying on the troughs.

We therefore tested the effect of deliberate washing. It was found that the depolarization of the poisoned half relative to the normal half observed when the muscle was mounted and stimulated in air disappeared more or less completely when the whole muscle was afterwards washed in stirred normal Ringer solution. We then attempted to determine the time-course of the electrical potential change accompanying the development of rigor while the whole muscle, one half of which was previously poisoned, was continually washed except during the short times required for potential measurements. Curve *C* represents the result when the washing solution was normal Ringer. It is seen that the depolarization of the poisoned half normally occurring during the first 30–40 min. after the beginning of stimulation was completely suppressed.

There is thus a strong indication that the initial depolarization accompanying the development of rigor was due to the release of some depolarizing substance by the muscle when developing rigor. In all probability this substance was potassium. Dean[1] has previously reported that iodoacetate-poisoned muscle, after the onset of rigor, lost a large amount of potassium. The use of potassium-free Ringer solution as a possibly more efficient washing solution then suggested itself, and the result was as shown in curve *D*, the two curves *C* and *D* being given by a symmetrical pair of muscles at 23° C. treated in identical manner except for the composition of the washing solution, and therefore directly comparable.

It is seen that, under the conditions of continuous washing with potassium-free Ringer solution, the initial phase of depolarization may be not only completely suppressed, but even actually replaced by a phase of large positive variation. That the half of the muscle subjected to rigor under these conditions contained less potassium than the normal half had been ascertained by separate potassium analysis of the two halves. A mere smaller potassium content of that half, however, could not account for its relative positivity. We had soaked half the muscle in potassium-free Ringer solution overnight, and then washed the whole muscle in potassium-free Ringer for half to one hour. The end which had previously been soaked in potassium-free Ringer solution overnight, while containing less potassium as afterwards determined by analysis, showed no relative positivity.

It may be concluded that when secondary change resulting from the release of potassium is eliminated, the development of rigor in iodoacetate-poisoned muscle is not accompanied by depolarization. Indeed, the primary event might even be an increase of polarization.

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Nervous Mechanism in Tunicata

DESPITE the contributions of Lorleberg[1], Hilton[2], Hecht[3], Cate[4], Bacq[5] and Das[6], the picture of tunicate nervous relations is still incomplete. Although the central nervous system consists of only one compact intersiphonal ganglion and the peripheral system of a few nerves emanating from the former, the extreme sensitivity of monascidians to touch, vibrations, etc., is astounding. A person walking about in a room where expanded *Ciona*, *Ascidiella*, or *Styelopsis* are lying in a jar on a table is enough to make some of the ascidians contract. Lorleberg[1] stated that *Styelopsis* had free nerve terminations, whereas Das[6] found in *Herdmania* an extensive nerve supply, not only to the organs lying inside the mantle, but also to receptor cells of the test as well. I have now found these nerve fibres, ramifying into the mantle, the test, and ending in the receptor organs, in *Ciona*, *Ascidiella* as well as *Styelopsis*. Free nerve terminations have been found in *Styelopsis* and *Ascidiella* and probably occur in all Tunicata.

The nerves arising from the intersiphonal ganglion have both afferent and efferent fibres in them; and as they branch and subdivide to supply the muscles and the receptors, the afferent and efferent fibrils are separated to form the peripheral nerves. It has also been established that, in crossed reflexes, nerve impulses pass directly from one siphon to the other by way of the ganglion. Removal of the ganglion not only prevents crossed reflexes but also affects the threshold of sensitivity and rate of recovery.

A complete account of the nervous mechanism in the Tunicata is being published elsewhere.

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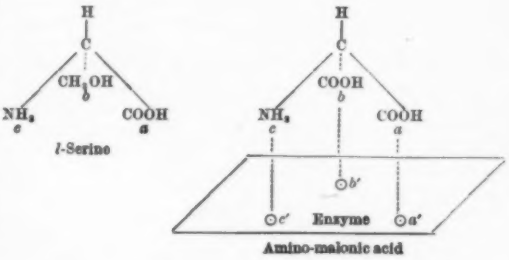
Interpretation of Experiments on Metabolic Processes, using Isotopic Tracer Elements

IN two instances, the distribution of isotopic carbon in the product of a metabolic process has been used to infer that a symmetrical intermediate compound is not involved. Wood *et al.*[1] showed that isotopic carbon, introduced as carbon dioxide together with pyruvate, led to the formation of ketoglutarate which contained isotopic carbon only in the carboxy group next to the keto group; on these grounds, they excluded citrate as an intermediate. Shemin[2] found that when glycine is formed from serine, containing isotopic nitrogen and isotopic carbon in its carboxy group, the relative abundance of nitrogen-15 and carbon-13 in the glycine was the same as in the serine; he argued that amino-malonic acid is therefore not an intermediate in this process.

These conclusions seem to arise from the fallacy that, because symmetrical products arising from the *d*- or *l*-form of an optically active precursor cannot be distinguished, therefore the two identical groups of a symmetrical product formed from one optical antipode cannot be distinguished. On the contrary, it is possible that an asymmetric enzyme which attacks a symmetrical compound can distinguish between its identical groups. This power of distinction is illustrated for the case of amino-malonic acid in the accompanying formulæ. a', b', c' represent points in the enzyme which specifically combine with the groups a, b, c of the substrate. Evidently, decarboxylation could occur at a' but not at b', or *vice versa*. The same conclusion follows if any three of the groups of the substrate specifically combine with the enzyme. If decarboxylation occurs only at b', then all the isotopic carbon in the carboxy group of serine will appear in the glycine. The case of the formation of ketoglutarate from citrate is exactly parallel.



This argument depends on two conditions: (*a*) that the sites a' and b' are catalytically different; (*b*) that three-point combination occurs between the symmetrical substrate and the enzyme; such combination is, of course, necessary wherever a single optical antipode is formed enzymatically from an inactive precursor. Since neither is unlikely, it follows that the asymmetrical occurrence of isotope in a product cannot be taken as conclusive evidence against its arising from a symmetrical precursor.

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Cultivation of *Trypanosoma cruzi* in the Developing Chick Embryo

ALTHOUGH *Trypanosoma cruzi*, the causative agent of Chagas' disease in South America, has been successfully cultivated in the embryonic tissues of the chick, attempts at growing this parasite in the developing chick embryo have hitherto led to inconclusive results. Roubaud and Romana[1] inoculated *T. cruzi* into the chorio-allantoic membrane of chick embryos from (*a*) a rich culture; (*b*) drops of liquid excreta of *Rhodinus prolixus* containing metacyclic forms; and (*c*) citrated blood of an infected guinea pig containing numerous large and active trypanosomes. The results were negative, and no infection was observed, except that in one embryo inoculated with the citrated blood a single trypanosome was found to have persisted on the membrane a week after inoculation. Rodhain and van den Berghe[2] inoculated

a dozen eggs with a strain of *T. cruzi* cultured in Novy–MacNeal–Nicolle medium. Three of the embryos became 'infected'; but attempts to effect a second passage in embryos did not succeed, and sections of the membrane of an 'infected' embryo did not show any trace of an invasion of the membrane or intracellular developmental stages. Rodhain and van den Berghe concluded that a true infection had not been established and that, probably, cellular invasion of the chick embryo does not occur, but that, as the parasite grows readily in tissue cultures of the chick embryo, the results need verification.

Recently I have succeeded in producing infection in chick embryos with both cultural and blood forms of *T. cruzi*.

The strain of *T. cruzi* was obtained from Dr. D. G. Davey, Imperial Chemical Industries, Manchester, on February 4, 1943, and since has been maintained in this Institute in mice. The inocula were composed of (*a*) equal parts of heart blood (drawn aseptically) from infected mice and sterile citrate-saline solution; and (*b*) a rich culture on Novy–MacNeal–Nicolle medium. The eggs were used after 10–14 days incubation, and the inoculations were made on to the chorio-allantoic membrane by the standard technique described by Beveridge and Burnet[3]. The eggs were opened from the third day onwards after inoculation, the membrane was fixed for sectioning, and heart blood from the embryo was examined for trypanosomes.

Twenty-four embryos were inoculated, twelve with culture and twelve with the citrated blood. Six were found dead on opening, and were discarded. All the others were infected and showed characteristic macroscopic lesions on the membrane which, on microscopic examination of the sections, are seen to be produced by the invasion of the membrane by the parasite and its active intracellular multiplication. All the stages of intracellular development characteristic of the parasite in the vertebrate host have been found in the membrane. The free extracellular trypanosomes appear in the blood of the embryo on the fifth day after inoculation. None of the inoculated embryos has so far survived to hatch out.

Macroscopically, the lesions appear as whitish opaque granulations scattered over the entire inoculated area of the membrane (Fig. 1). In some cases a tendency for the lesions to concentrate into groups was observed. The membrane as a rule is thickened and rigid, and the blood vessels tend to dilate. The lesions are evident on the third day after inoculation and become very numerous and highly specific on the fifth day.

Sections of the infected membrane show numerous 'cysts' on the surface of the ectoderm or deeper down in the same layer. These 'cysts' enclose large numbers of leishmania stages of *T. cruzi*. Apparently the individual trypanosomes from the inoculum invade ectodermal cells and round up into leishmania stages which then undergo repeated divisions. The infected cell is ultimately reduced to a bag or membrane surrounding the parasites, and this gives rise to the characteristic 'cyst-like' appearance. The host cell is very much hypertrophied and its nucleus large and degenerate. The ectodermal cells around the invaded cell proliferate actively and the whole area gets considerably thickened, thus forming the characteristic lesion. It is usual to find several such groups of leishmania stages inside one lesion (Fig. 2). The crithidial forms have been observed in sections of membrane fixed five days after inoculation. The proliferation of the ectoderm cells is accompanied by cornification and necrosis. The mesoderm layer is unaffected, except for the presence of large numbers of eosinophil leucocytes and for slight œdema. Red blood cells and leucocytes are frequently seen below the ectoderm. The endoderm does not appear to be affected in any way.

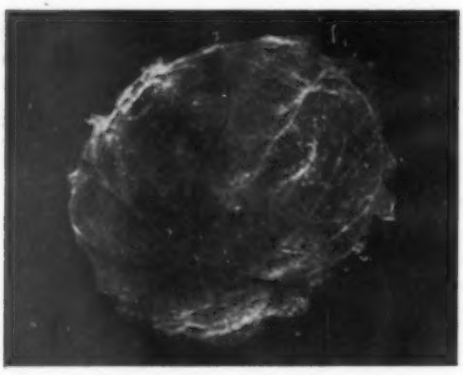

Fig. 1. Photograph (approximately one and a half times natural size) of chorio-allantoic membrane showing typical specific lesions produced by *T. cruzi* five days after inoculation with a culture in Novy–MacNeal–Nicolle medium

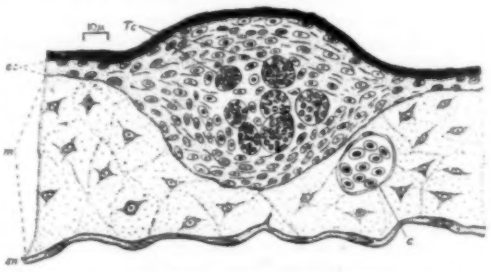

Fig. 2. Section of chorio-allantoic membrane showing a lesion containing leishmania stages of *T. cruzi* three days after inoculation with citrated blood of an infected mouse: *c*, capillary; *ec*, ectoderm; *en*, endoderm; *m*, mesoderm; *Tc*, Leishmania stages of *T. cruzi*

Thus, contrary to the results obtained by previous workers, it has been found that chick embryos, of 10–14 days incubation, may be infected readily with either cultural or blood forms of *T. cruzi*, and that characteristic lesions are developed in the chorio-allantoic membrane of the infected embryos. The cultivation of *T. cruzi* in chick embryos opens up a promising field for studies on the action of drugs on the intracellular stages of this trypanosome. Further experiments are in progress, and a fuller account of the intracellular development of *T. cruzi* and the histopathological changes in the host will be published elsewhere.

My thanks are due to Dr. P. Tate for supplying infected mouse blood for the above experiments.

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Phosphorylation of Myosin by Adenosine Triphosphate

THE study of the interaction between actomyosin and adenosine triphosphate has hitherto given evidence of physical changes in the protein and of its enzymic activity. Very little was known, however, of chemical changes in the protein molecule accompanying the physical effects. Phosphorylation of the protein[1] and formation of an adenosine triphosphate-protein compound[2] have been suggested as alternative possibilities, but conclusive experimental evidence has not yet been presented.

Content in phosphate and adenine (μgm./gm. threads)

Temperature			0° C.						37° C.						
	Substances applied	No. of experiments	P_0	P_γ	P_T	$P_\gamma - P_0$	$P_T - P_\gamma$	A	No. of experiments	P_0	P_γ	P_T	$P_\gamma - P_0$	$P_T - P_\gamma$	A
Actomyosin	Water	22	1·20	2·35	4·20	1·15	1·85	11·35	15	0·95	2·25	4·10	1·30	1·85	10·20
	Water	5	1·00	2·35	4·35	1·35	2·00	11·30	2	1·30	2·30	5·55	1·00	3·25	11·00
	ATP*	9	2·85	5·50	7·80	2·65	2·35	14·40	13	4·80	8·65	12·10	3·85	3·45	17·05
Actin-free myosin	Water	4	1·15	1·90	2·85	0·75	0·95	9·20	4	1·60	2·35	3·95	0·75	1·60	10·55
	ATP*	10	6·25	9·35	13·95	3·10	4·60	18·15	8	9·20	12·30	17·10	3·10	4·80	20·30
Actomyosin with low adenosine triphosphatase activity	Water	1	1·40	2·15	4·00	0·75	1·85								
	ATP*	2	5·50	7·85	12·55	2·35	4·70		2	6·75	9·00	16·75	2·25	7·75	
	ATP + KCl + $MgCl_2$†	2	11·45	13·10	20·40	1·65	7·30								

* 2×10^{-4} mol./ml. adenosine triphosphate.

† 2×10^{-4} mol./ml. adenosine triphosphate + 1×10^{-4} mol./ml. potassium chloride + 1×10^{-4} mol./ml. magnesium chloride.

Actomyosin and actin-free myosin threads contain appreciable amounts of adenine, ribose and phosphorus which cannot be removed by repeated washing, but are extractable after denaturation. In the protein-free extracts the phosphorus is present as orthophosphate (P_0), readily hydrolysable phosphate ($P_\gamma - P_0$) and difficultly hydrolysable phosphate ($P_T - P_\gamma$).

Treatment with adenosine triphosphate causes a considerable increase in adenine, ribose and the different phosphate fractions, not removable by repeated washing (see table). The ratio of readily hydrolysable phosphate and phosphate hydrolysable with difficulty to adenine corresponds roughly to the ratio calculated for adenosine diphosphate.

The uptake of adenine, ribose and phosphate can be observed only after the application of adenosine triphosphate. No uptake of either nucleotide or phosphate follows treatment of the protein with adenosine diphosphate, adenylic acid, orthophosphate or pyrophosphate. The effect of adenosine triphosphate is independent of the adenosine triphosphatase activity of the protein, as threads from preparations with high and low enzymic activity give the same results. Inosine triphosphate and inorganic triphosphate, which are both split by adenosine triphosphatase, produce neither an uptake of nucleotide nor of phosphate. Furthermore, an increase in temperature from 0° C. to 37° C. is accompanied by a much higher increase in enzymic activity than in nucleotide and phosphate uptake.

The orthophosphate found in the protein-free extract must originate from highly labile phosphate bound to the protein, that is, it is the expression of a phosphorylation of the protein. It can scarcely be present as orthophosphate before denaturation, because orthophosphate is quantitatively removed by the washing preceding denaturation.

While phosphorylation and nucleotide uptake are independent of the enzymic activity of the protein, a close correlation exists between chemical effects and constriction of volume. Both phenomena require the presence of adenosine triphosphate, which is highly specific for both reactions. In increasing concentrations adenosine triphosphate causes increasing phosphorylation and nucleotide uptake as well as increasing volume constriction. Addition of magnesium salts, which enhances the latter effect, also increases phosphorylation.

Adenosine triphosphate causes phosphate and nucleotide uptake both in threads of actomyosin and actin-free myosin, whereas the constriction of volume occurs only in the presence of actin. Hence, the chemical changes must be localized in the myosin moiety of the protein.

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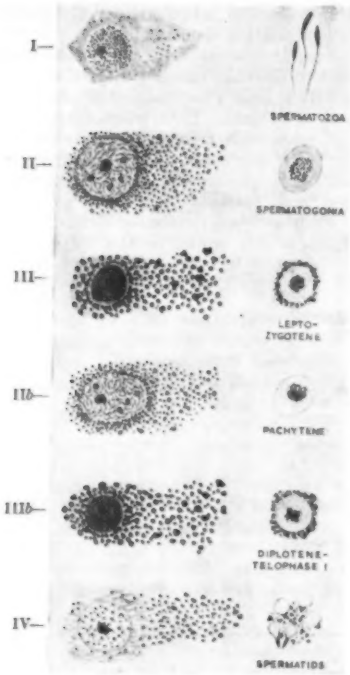
Ribonucleic Acid Supply and Phosphatase Distribution during the Spermatogenesis of *Asellus aquaticus*

STUDIES on the spermatogenesis of *Asellus aquaticus* L.[1] directed attention to the polyploid cells surrounding each testicular lobe. It has been found that these cells show cyclic variations of morphological characters both in nucleus and in cytoplasm which correspond to different phases of spermatocytic evolution. The latter is almost synchronous in each lobe, and a small bunch of spermatogonia remains in the basal portion of the lobe, to ensure the next spermatogenetic wave.

The nuclei of the surrounding cells are polyploid of the *Gerris* type[2], that is, with chromosomes



preserving their individuality. No large chromocentre is present. The cytoplasm may be more or less filled with basophil granules, which tested by Brachet's method (Unna–Pappenheim stain and control by pretreatment with ribonuclease) appear to be very rich in ribonucleic acid, perhaps entirely formed of this substance.

The variations may be summarized as follows. Stage I corresponds with fully formed spermatozoa. Nucleus large, chromatin of each chromosome much contracted. Cytoplasm devoid of granules. Stage II corresponds with spermatogonia. Nucleus larger, chromatin much more dispersed and chromosomes threadlike. Cytoplasm with a few granules, especially abundant around the nuclear membrane. A few granules are found excreted between the spermatogonia. The spermatogonial cytoplasm stains pink with pyronin. Stage III corresponds with spermatocytes in lepto-zygotene. Nucleus small, very contracted, chromatin more diffuse. Cytoplasm heavily charged with large granules of ribonucleic acid, which are excreted into the interstices between the spermatocytes. Spermatocyte cytoplasm stains a brilliant pink. Stage II *b*. At pachytene the follicular cells are again in stage II, and the germ cells appear to have exhausted their supply of ribonucleic acid in cytoplasm. Stage III *b*. At diplotene to telophase I, the follicular cells are again in stage III, while the cytoplasm of the germ cells stains red (especially so at metaphase I). Stage IV corresponds with telophase II to spermatids. Chromatin resumes the granular form (that is, contracted chromosomes). The cytoplasm is vacuolated and devoid of granules. Some of them are still present outside the cells and between the young spermatids, the majority of which have their tails oriented toward the clots of granules.

There are one or two nucleoli in every stage except stage II, in which three to six supplementary nucleoli appear. In every stage nucleoli stain faint pink, except in stage III, in which the main nucleoli stain deep red.

With Gomori's technique for phosphatases, using as substrate either sodium glycerophosphate β or polymerized desoxyribonucleic acid or ribonucleic acid, the following results have been obtained. (*a*) The monophosphatases and diphosphatases are present in the nuclei, both of follicular cells and germ cells; they are localized on chromatin and nucleoli (see below). They are probably absent from the cytoplasm and certainly from the granules. (*b*) Mono- and diphosphatases are present in the main nucleolus at every stage. In stage II they are present together in two or three of the supplementary nucleoli, while in the remainder only monophosphatases are present. Since it is probable that phosphatases are concerned with the metabolism of nucleic acids[2–5], we are inclined to think that the metabolism of ribonucleic acid occurs only at two points, namely, (i) the polyploid nucleus as the starting point, and (ii) the germ cell nucleus as the end point. Moreover, it appears that the highest charge in phosphatases corresponds to stage III, so that probably this is the phase with the greatest production of ribonucleic acid.

From the observations it follows that: (*a*) The follicular cells elaborate and secrete ribonucleic acid, which is supplied to the germ cells. (*b*) The nucleus takes part in the secretory activity of the cell and shows evident structural changes. (*c*) During a spermatogenetic cycle the polyploid cells undergo two waves of secretion, with two peaks corresponding respectively to lepto-zygotene and diplotene-telophase I. (*d*) Spermatocytes absorb and utilize ribonucleic acid, which is supplied in this way by the follicular cells.

The mechanism of feeding nucleic acids to the male germ cells of *Asellus* thus differs slightly from that found by Painter and Reindorp[6] in the oocytes of *Drosophila* and by Painter[7] in the anthers of *Rhoeo*.

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Electrical Resistance of Wires with Large Strains

Some time ago, K. H. Swainger[1] directed attention to the remarkable linearity of the electrical resistance of 'Minalpha' wires with large strains, optically measured. As this observation has important consequences on strain measurements, it seemed worth while to examine wires of other materials for the effect. Preliminary experiments showed that for all materials tested the specific increase of the electrical resistance was approximately equal to twice the specific elongation of the wire, if well above the yield point. This result made it obvious that the change of the electrical resistance is mostly a geometrical property, and was not due to a change of the resistivity of the material.

Thus, with the two assumptions that the resistivity of the material and the volume of the wire remain unchanged at large strains, it is easy to see that the resistance R with its initial value R_0 is connected to the actual length L of a uniformly strained wire of initial length L_0, by the expression:

$$\frac{R}{R_0} = \left(\frac{L}{L_0}\right)^2;$$

which for small values of $\Delta L/L_0$ may be written

$$\frac{\Delta R}{R_0} = 2 \cdot \frac{\Delta L}{L_0}.$$

'Copel', a copper–nickel alloy from the Hoskins Manufacturing Company, Detroit, has shown the largest elongation, with the remarkable value of about 35 per cent, but we have in some cases found values as high as 60 per cent. As may be seen from Table 1, the two basic assumptions are excellently verified for this material.

Table 1. Static test on 'Copel' wire. $L_0 = 125$ mm.; diameter, 0·45 mm.

ΔL (mm.)	R (ohm)	R/R_0	$(L/L_0)^2$
0	0·376	1·000	1·000
6·25	0·414	1·101	1·102
12·50	0·455	1·210	1·210
18·75	0·497	1·322	1·322
25·00	0·542	1·442	1·440
31·25	0·588	1·564	1·562
37·50	0·635	1·689	1·690

Wires of other materials showed resistances a little less (0·5–1 per cent) than the calculated values, probably due to the elastic part of the strain.

As the electrical resistance is determined by the dimensions of the wire only, it seemed plausible that the rate of strain would not affect the resistance-strain relation, though it affects strongly the stress-strain curve.

In order to confirm this, the wire was rapidly stretched by releasing a spring, between which and the wire a plate provided with slits at 2-mm. intervals was inserted. The resistance-time curve was taken as an oscillogram, on which every 2 mm. of elongation were marked using a photocell guided by these slits. The results are shown in Table 2, where v denotes the velocity of the moving end of the wire.

Table 2. Dynamic test on 'Copel' wire. $L_0 = 101$ mm.; diameter, 0·45 mm.

v (m./s.)	ΔL (mm.)	R (ohm)	R/R_0	$(L/L_0)^2$
0	0	0·303	1·000	1·000
1·8	2·1	0·316	1·043	1·042
2·6	4·1	0·328	1·082	1·083
3·1	6·1	0·342	1·129	1·124
3·5	8·1	0·354	1·168	1·167
3·9	10·1	0·367	1·211	1·210
4·4	14·1	0·394	1·300	1·299
4·8	18·1	0·422	1·393	1·391
5·2	22·1	0·451	1·488	1·485
5·6	26·1	0·477	1·574	1·584
5·9	30·1	0·509	1·680	1·685
6·2	34·1	0·541	1·785	1·789

Similar results have been obtained with a 200-mm. wire. The differences between the two last columns lie within the errors of observation.

We have found it possible to use these plastic strain gauges with advantage to measure the extremely rapid increase of diameter of detonating shells and the like.

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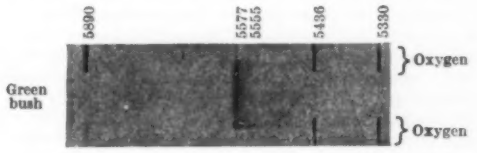
The Green Auroral Line as an Initiator of Phosphorescence in Condensed Systems

In 1924 one of us (L. V.)[1] detected a number of phosphorescent bands produced when solidified mixtures of nitrogen with inert gases (argon or neon) were exposed to the bombardment of cathode rays. One of these bands, called N_1, was situated in the region of the green auroral line. With diminishing nitrogen concentration the width of the line diminished and in pure neon it took the shape of a diffuse line with a wave-length 5577·4 A., which within the limit of error was identical with that[2] of the auroral line 5577·35. From this result, Vegard concluded that he was actually observing the green auroral line, which, however, under certain conditions took the form of a phosphorescent band, due to the action of Van der Waals' forces[3] between the molecules of the condensed system.

After McLennan and collaborators had shown that the green auroral line originated from transitions between the metastable ground-states $^1S_0$ and $^1D_2$ of the normal oxygen atoms, Vegard[4] expressed the view that the coincidence between the auroral line and the N_1-band observed in solidified inert gases and in their mixtures with nitrogen was not likely to be accidental, and that further studies of the phosphorescent band might show some relationships; in other words, that the band was initiated by traces of oxygen, which act as nuclei of the phosphorescence. Now we have recently been able to study a most interesting luminescence effect which strongly supports this view.

In connexion with the production of inert gases undertaken by the Norwegian firm "Norsk Hydro-Elektrisk Kvaelstofaktieselskab", J. Nordhagen recently found that a sample of purified argon, when tested at atmospheric pressure by a Tesla transformer, showed a green bush of luminescence not previously found by similar tests of other samples. It was therefore of importance to find the origin of the phenomenon in order to make sure that it was not due to impurities of some sort. We were consulted on the matter and asked to undertake a spectral analysis of the luminescence.



The spectrograms showed that the green bush consists of a single green band dominated by a somewhat diffuse line with continuous light on both sides. The wave-length of the line was measured and found to be 5577. Thus within the limits of error, the wave-length is equal to that of the auroral line 5577·35 A. A spectrogram was also taken with a comparison spectrum obtained from an oxygen discharge tube which gave the green auroral line. As seen from the reproduced spectrogram, the line in the phosphorescent band from argon coincides exactly with the auroral line. The spectrograph had at this wave-length the fairly large dispersion of 50 A./mm. Towards longer wave-lengths the continuous light extends to 5585; and towards short wave-lengths to about 5400.

The reason for the different behaviour of the old and new samples was found to be that the latter contained less oxygen. When the oxygen concentration of the new sample was increased to that of the previous ones, the green phosphorescence disappeared. Thus the essential condition for the appearance of the phosphorescent band initiated by the green auroral line is that oxygen is present in extremely small concentrations. The green luminescence showed an afterglow, sometimes lasting for a few seconds.

In the experiments with the *solidified* gases, previously referred to, the solid layers unavoidably contained traces of oxygen, and it is therefore very likely that the green N_1-band, which in neon had the wave-length 5577·4, is a phosphorescence phenomenon initiated by the green auroral line. In solidified systems a red band N_2 (6320) was observed, which might be initiated by the red auroral O I-doublet (6300·3, 6364).

In the case of gaseous argon we have not yet observed a red band corresponding to the red O I-doublet.

Investigations into the nature of this phosphorescence phenomenon, detected by Mr. Nordhagen in gaseous argon containing traces of oxygen, will be continued.

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Some New Ferromagnetic Manganese Alloys

The ferromagnetic beta phases in the systems copper–manganese–aluminium and copper–manganese–tin have been shown to have an ordered body-centred cubic structure, and the compositions of alloys showing maximum magnetizations correspond to atomic proportions[1,2] Cu_2MnAl and Cu_2MnSn. Valentiner has recently reported that ferromagnetic alloys exist in the system copper–manganese–indium. The highest intensity of magnetization is shown by the composition Cu_2MnIn, and the structure is analogous to that[3] of Cu_2MnAl and Cu_2MnSn.

The position of gallium in the periodic table relative to aluminium, indium and tin, and the similarity of the equilibrium diagrams of the binary systems copper–aluminium, copper–tin, copper–indium and copper–gallium suggest that a ferromagnetic beta phase might exist in the ternary system copper–manganese–gallium.

We have investigated three copper–manganese–gallium alloys having the following compositions (Table 1).

Table 1

Alloy designation	Weight per cent Cu	Mn	Ga
*G*1	49·5	21·6	28·9
*G*2	62·3	13·0	24·7
*G*3	57·8	16·0	26·2

Specimens of alloy *G*1 quenched from temperatures between 500° C. and 750° C. all showed a two-phase structure under the microscope, and were very feebly magnetic. The highest intensity of magnetization was shown by a specimen quenched from 650° C. This specimen had a saturation magnetization at room temperature of about 2½ per cent of that of nickel. This value was doubled on ageing the specimen at 100° C. for 110 hours. The composition of alloy *G*1 corresponds to atomic proportions $Cu_{1.97}Mn_{1.00}Ga_{1.03}$.

Alloys *G*2 and *G*3 were quite strongly magnetic after being quenched from 750° C., and under the microscope had an acicular appearance like martensite. Alloy *G*3 had a saturation intensity of magnetization at room temperature about seven-tenths of that of nickel. Cooled slowly from 750° C., this alloy became non-magnetic, and microscopic examination showed that a transformation had taken place. Ageing of alloy *G*3 at 100° C. and 200° C., following quenching from 750° C., caused a reduction in saturation magnetization; but no transformation was apparent under the microscope.

Table 2. X-ray diffraction data for alloy *G*3 (quenched from 750° C.)

Radiation	Intensity	*d*	Radiation	Intensity	*d*
FeKα	ww	2·446	FeKβ	ww	1·328
β	ww	2·294	α	m	1·335
α	m	2·286	β	ww	1·292
			α	s	1·295
β	ww	2·122			
α	s	2·127	α	s	1·207
			α	w	1·148
β	m	2·019			
α	ss	2·018	α	m	1·135
			α	ss	1·108
α	m	1·968			
			α	m	1·076
α	m	1·556	β	w	1·062
			α	m	1·067
α	m	1·532			
			α	w	1·011
α	m	1·371			

X-ray diffraction photographs were taken at room temperature of powder specimens, quenched from 750° C., of alloys *G*2 and *G*3. Both patterns were of the same type, and the data for alloy *G*3 are listed in Table 2. A satisfactory interpretation of these data could not be made. The lines observed cannot be reconciled with those to be expected from the beta structure, ordered or unordered. Weibke states that the beta copper–gallium alloys resemble beta copper–aluminium alloys in that the structure of quenched alloys depends upon the cooling velocity[4]. The same behaviour was noted by Hume-Rothery and Raynor[5]. The martensitic structures observed in quenched alloys could possibly be derived from the beta phase, stable at high temperature, but not retained by quenching.

Preliminary experiments have shown that ferromagnetic phases exist in the binary systems manganese–germanium and manganese–indium, and in the ternary system copper–manganese–germanium. Investigation of these systems is being extended with the view of identifying the ferromagnetic carriers. It is also suggested that ferromagnetic phases might exist in the binary system manganese–gallium.

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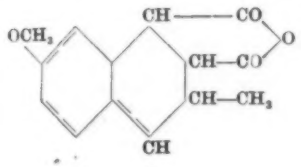
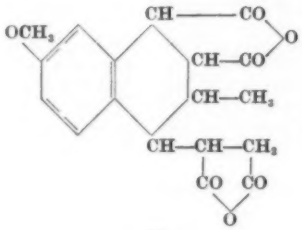
Addition of Maleic Anhydride to Anethole

In a communication bearing this title, and when referring to our papers[1] on the uncrystallizable compound (m.p. 311–312°) formed during the course of the reaction which takes place between anethole and maleic anhydride, Bruckner and Kovács[2] state that we have not recognized that this compound was a heteropolymer. In a series of other reports on the same subject published later, the heteropolymer character of the compound was established and, furthermore, its molecular weight was determined[3] with the help of the *cis*-hexahydro-*para*-aminobenzoic acid lactam[4]. The product which is obtained first under Bruckner's working conditions and our own, when refluxed with chloroform, yields two compounds, one of them soluble (m.p. 245° decomp.), with a molecular weight equal to 738 (theoretical for 3 : 3·735), and the other insoluble (m.p. 310° decomp.), with a molecular weight equal to 1,010 (theoretical for 4 : 4·980).



I



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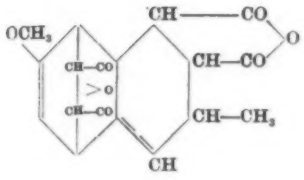

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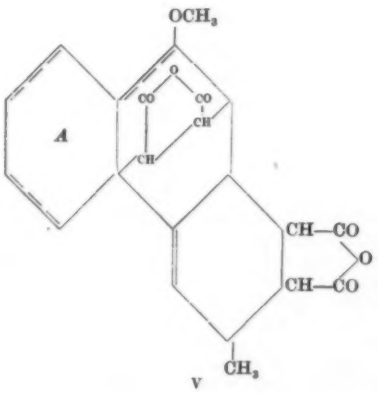
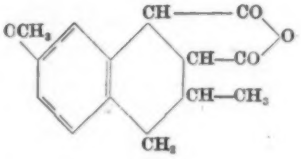


A



III

V

Bruckner and Kovács refer to the structure of the crystalline compound (m.p. 241°) formed by one mole of anethole and two moles of maleic anhydride, obtained by Bruckner in small quantities[5], and which he now obtains with a 60 per cent yield when a small amount of dimethylaniline is added.

We have found a crystalline compound (m.p. 232°) in this ratio of 1 : 2 with a yield of 30 per cent, when the condensation is carried out in the presence of hydroquinone, which acts as an inhibiting agent towards polymerization[3]; and, moreover, we have characterized crystalline products with the same molar ratio in the condensation of maleic anhydride with *o*-metoxypropenylbenzene (m.p. 241°)[6] and 1-4-metoxypropenylnaphthalene (m.p. 256–257°)[7].

Concerning the structure of the compound formed, Bruckner considers that, from the point of view of diene synthesis, anethole behaves as a conjugated tetraene which would react successively as shown by I and II. Though we do not deny this possibility, we have directed attention to the possibility that the reaction takes place in the form indicated in III and IV, where the second molecule of maleic anhydride would react, following a process of substitution addition already mentioned by Adler[8] as coincident with the diene synthesis.

The ultra-violet absorption spectra of these compounds are of the same type as that found for tetraline. When heated with selenium to 220°, characterization of the corresponding methyl-oxydicarboxylic acids, formed through loss of the second maleic anhydride molecule, is accomplished. With Bruckner's structure this may evidently take place due to the tendency of the nucleus to become aromatic; with our own, through elimination of the lateral chains, in this case of succinic acid, a process usually accompanying the hydrogenation reactions. On the other hand, in the case of 1-4-metoxypropenylnaphthalene it would be necessary to make allowance, following Bruckner, for the entrance of a second molecule as shown in V, and furthermore for the possibility of a new molecule adding itself to the conjugation in *A*; but we have found no compounds in the ratio of 1 : 3.

We are studying now the possibility of a reaction of substitution addition with the allylic isomers of these diene compounds which, taking place in these cases with transposition[9], gives rise to a conjugation capable of reacting, in the form of a diene synthesis, and producing compounds showing a structure which can be compared to that of those under consideration. The results and details of these investigations will be published elsewhere.

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[1] Lora-Tamayo, M., and Ayestarán, D., *Anal. Fis. Quím.*, **36**, 44 (1940); **37**, 392 (1941).
[2] Bruckner and Kovács, *Nature*, **161**, 650 (1948).
[3] Lora-Tamayo, M., and Iñiesta, J. L., *Anal. Fis. Quím.*, **39**, 634 (1943).
[4] Lora-Tamayo, M., and González, A., *Anal. Fis. Quím.*, **39**, 525 (1943).
[5] Bruckner, *Ber.*, **75**, 2035 (1942).
[6] Lora-Tamayo, M., and Martín Panizo, F., *Anal. Fis. Quím.*, **40**, 401 (1944).
[7] Lora-Tamayo, M., Martín Panizo, F., and Viguera, J., *Anal. Fis. Quím.*, **41**, 1325 (1945).
[8] Adler and Cow, *Ber.*, **76**, 40 (1943).
[9] Adler, *loc. cit.*; Lora-Tamayo, M., and Larraz, M. C., *Anal. Fis. Quím.*, **44**, 223 (1948).

Interpretation of Data from Electrical Resistivity Geophysical Surveys

In connexion with the note by J. M. Hough on work by himself and Prof. L. S. Palmer of University College, Hull[1], I should like to direct attention to a method I described briefly in 1934, and which I have been practising since that date[2].

It will be noticed that I use the ratio ρ_a/ρ_1 for application to standard curves, of which I have sets in many forms. In all cases I obtain solutions by superposition of field curves on transparent paper, having long ago calculated sufficient values for complete sets of curves.

In the solution of multilayer problems I have used proportional compasses and thereby obtain four or five similar curves for superposition on standard curves, from which the 'scale', that is, the effective value of ρ_1, is obtained. I am grateful for the suggestion of using logarithmic plots, which are similar in shape and result merely in a shift of the axes according to 'scale'.

Finally, I would like to suggest to Prof. Palmer and Mr. Hough that a day in the field using my method will convince them of the advantages of my lay-out, in which a is fixed and α varied. A small handbook is now in the press giving details of the method and standard curves for the use of Survey officers.

Incidentally, there is a printer's error in the formula in my paper[2] at the foot of p. 276, owing to my not being able to check the proofs; it should read:

$$\frac{\rho_a}{\rho_1} = 1 + 2f(f+1) \sum_{n=1}^{n=\infty} k^n \left[\frac{1}{(f^2 + 4\lambda^2 n^2)^{1/2}} - \frac{1}{((f+1)^2 + 4\lambda^2 n^2)^{1/2}} \right]$$

W. G. G. Cooper

Geological Survey Department,
Zomba, Nyasaland.

[1] *Nature*, **161**, 812 (1948).
[2] *Mining Mag.* (Nov. 1934).

The comparison of field curves with sets of standard curves, as suggested by Mr. W. G. G. Cooper, is one method of interpreting results. This method requires a large number of standard curves even for the two-layer case, as there are two variables, namely, the depth of the surface layer and the ratio of the resistivities of the two layers. The number of standard curves is reduced to a single set when logarithmic curves are used, as suggested by Whitehead and Radley[1] and in my original letter[2]. Mr. Cooper agrees with me that for multi-layer curves the use of logarithmic curves is a definite advantage.

Mr. Cooper's method for field-work has obvious advantages over our method in needing a smaller operating team. When α is small, the potential difference between the potential electrodes is small, and this may cause the method to be insensitive for these readings. Although the usual electrode-layout is that due to Wenner, there are many other possibilities, and we hope to make an investigation into some of these in the near future. We expect that the most suitable electrode arrangement will depend upon the particular geological structure to be investigated.

J. M. Hough

University College, Hull.

[1] Whitehead, S., and Radley, W. G., *Proc. Phys. Soc.*, **47**, 589 (1935).
[2] Hough, J. M., *Nature*, **161**, 812 (1948).

Blinking

In recent discussions on blinking[1], it has been taken for granted that, in a physical experiment, an object cannot be kept under continuous observation. The difficulty, however, is easily overcome. It is easy to acquire the habit of blinking the eyes alternately and, provided the period is made slightly shorter than that associated with normal blinking, no discomfort results.

I have used this technique in the laboratory for more than twenty years, and have always assumed that it was generally known; but this, apparently, is not the case.

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Cambridge.

[1] Lawson, R. W., *Nature*, **161**, 154 (1948); **162**, 531 (1948).

Dr. Clark's interesting and novel method of avoiding the interruption of vision due to blinking assumes that blinking is suppressed when the subject 'winks' periodically with alternate eyes. After repeated trials, I doubt whether this assumption is justified. Moreover, few people are aware of their normal rate of blinking.

Almost the whole of the lid movement during blinking is performed by the upper lid, and the two lids meet roughly at the level of the base of the iris. The period of blackout during blinking is made up of two parts: the time taken by the upper lid to traverse in both directions the lower iris, and the time during which the lids are in contact. In general, the vision is 'mobile' during the whole of the blink, and for a short time afterwards (Lawson, *l.c.*). Both blackout and mobile vision become serious only at relatively high rates of blinking.

In 'winking', on the other hand, the lid movement is shared about equally by the upper and lower lids, and contact is established in general over the pupil. The period of blackout for each eye is consequently restricted to the time of contact of the lids, and is thus shorter than the blackout due to blinking. The vision of the winking eye is, however, mobile during the whole of the wink, owing to the development of a mobile diplopia caused apparently by refraction in the superficial corneal fluid as the lids approach each other. The existence of this diplopia in binocular vision during winking can readily be demonstrated by holding the wink, when two images are clearly visible. For myself it amounts to about 1° in the field of vision, the direction of displacement varying from subject to subject. On the other hand, the mobile vision due to eyeball rotation associated with blinking amounts to only ½° in the field of vision (*l.c.*).

Thus, although the effect of blackout is largely eliminated by the process of 'winking' alternately in binocular vision, mobile vision is enhanced and becomes much more disturbing. The 'cure' seems to be worse than the 'disease', and I am not clear how it can be applied to observations through a 'monocular' microscope.

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University,
Sheffield 10.

GEOLOGY AND MINERAL RESOURCES OF AFRICA

AT the eighteenth session of the International Geological Congress held in London during August last, the Association of African Geological Surveys held a series of four meetings at which recent advances in the geology of Africa were announced, and discussions of special interest took place. The meetings were of truly international character, and the great interest they aroused is clear from the large attendances and the very considerable number of papers that were presented. Indeed, in many cases only the briefest time could be given to the reading of the papers, but the discussions on the important problems dealt with were of special value. The meetings bore striking testimony to the results already obtained by international co-operation in the whole field of African geology, and in addition indicated the means by which this co-operation could be fruitfully extended.

An important part of the activities of the Association was the presentation of new sheets of the International Geological Map of Africa, together with the co-ordinated description of natural regions; there were also discussions on general and special problems of African geology, and personal contributions on territorial problems.

A full account of the proceedings of the Association has been given by M. F. Blondel, secretary of the Association and director of the Bureau d'Études géologiques et minières coloniales, Paris, in *Chronique des Mines Coloniales* (Numéro Spécial, No. 147, Sept. 15, 1948), a journal well known to African geologists, and it will appear also in due course in the *Comptes rendus* of the International Geological Congress.

Recent advances in the geology and mineral resources of the British African Colonies were summarized in a paper by the directorate of Colonial Geological Surveys, which was based on descriptions by the directors of the British African Geological Surveys, most of which were given in the form of lectures at the Imperial Institute during the preceding year. These lectures and associated papers are shortly to be issued by the Imperial Institute in one volume, which will provide a most useful summary of the present position regarding the geology and mineral resources of these important Colonies.

This was the second session of the Association, the first having been held at the previous session of the International Congress in Moscow in 1937. The formation of the Association arose largely from the need for discussing various problems connected with the preparation of the International Geological Map of Africa; it was found, too, that there were many other problems of an international character that could usefully be discussed at periodical meetings, and the Association was accordingly formed to meet at the same time as the International Geological Congress. The next meeting of the Congress at Algiers in 1952 will be of special interest to all interested in African geology.

At the first meeting of the present session of the Association, Sir Edward Bailey was elected honorary president, Dr. F. Dixey president, and M. Blondel was re-elected secretary; Dr. Dixey then took the chair. All the African Geological Surveys were represented, and during the meetings fifty papers were presented with a view to inclusion in the *Comptes rendus* of the International Geological Congress, and there were also 109 contributions to the discussions.

M. Blondel reported on the work of the Commission of the International Geological Map of Africa. The Commission, which was formed at the International Geological Congress in Brussels in 1922, had as its object the preparation of a geological map of Africa on the scale of 1/5,000,000; M. A. Lacroix was elected president, and M. de Margerie secretary-general. For various reasons progress was at first slow, and in 1934 the task of preparation was taken over by the Bureau d'Études géologiques et minières coloniales, Paris, of which the director, M. Blondel, became the deputy secretary-general of the Commission. Owing to the magnitude of the task it was soon apparent that it would have to be carried out by an international body, and the Association of African Geological Surveys was formed very largely with the object of assisting the work of the Commission. It is none the less important not to overlook the fact that the immense task of compilation, drafting and publication has been performed at the Bureau d'Études géologiques et minières coloniales by M. Blondel and his staff; and the progress made with the map since 1937, in spite of the devastation of the intervening war years, reflects the highest possible credit on these collaborators, to whom all interested in the geology of Africa owe a great debt of gratitude.

In presenting the report of the Commission to the Association, M. Blondel referred to the death of M. A. Lacroix, who had been president of the Commission since its inception. M. de Margerie, who had greatly facilitated the work in its earlier stages, was elected president in his place, Sir Edward Bailey and Prof. Fourmarier were elected vice-presidents, and M. Blondel secretary-general; and it was agreed that the Commission should comprise the heads of the various African Geological Surveys, and certain eminent geologists with special knowledge of Africa.

M. Blondel showed that, of the nine sheets into which the map was divided, the first (No. 1, North-West) was published in May 1936, and presented to the Congress in Moscow; but owing to the loss of the stock of prints during the War, a reprint was made in 1946. Sheet No. 2 (Centre, North) was published in 1948, and No. 3 (North-East) in 1947; No. 4 (West) was presented in proof to the Congress in London; No. 5 (Centre) and No. 9 (South-East) were presented in manuscript form for discussion; and No. 7 (South-West) is reserved for the legend. There remain only No. 8 (South Africa) and No. 6 (East Africa), which are in active preparation, and there is good prospect that the work of the Commission will be wholly completed by the next Congress.

This great work has been financed very largely by France and the French African territories, and by Belgium and the Belgian Congo; Uganda, Southern Rhodesia and Egypt have also assisted. Considerable additional funds are urgently required for the completion of the work. Too large a share has clearly fallen on some countries and too little on others, and it is of the greatest importance that the British Colonies, among others, who stand to benefit so largely by this work, should in the future take a far

greater share in the financial burden than they have in the past.

Following the submission of M. Blondel's report, Dr. N. R. Junner proposed that a tectonic and mineralogical map of Africa should be prepared, and M. Blondel, on being asked, generously undertook this additional task, which should fulfil a want long felt by many African geologists.

Prior to the meeting, the Association had invited the various geological services in Africa to prepare descriptions of the regions for which they were responsible, and in almost all cases this invitation was accepted. During the meeting brief summaries of these contributions were given, covering the following extensive territories: French Morocco, Sahara, Libya, Egypt, French West Africa, Portuguese Guinea, the British Colonies, French Equatorial Africa, Western Belgian Congo, the Katanga, Angola, Northern and Southern Rhodesia, the Union of South Africa and South-West Africa, Madagascar. These papers present an excellent review of African geology in 1948, and it is hoped that they will all appear in due course in the *Comptes rendus* of the Congress.

A geological bibliography of Central Africa, with additions to 1944, recently published by Belgium and the Belgian Congo, was presented to the Association.

The Association had proposed for discussion a number of general subjects, most of which concerned the correlation of the older formations for the purposes of the International Map. A discussion on the Pre-Cambrian formations was opened by Prof. A. Holmes, who, on the basis of recent researches on the age determination of rocks by radioactive methods, and of the disposition of the different orogenic zones, suggested a number of correlations, which in some cases were at variance with those generally accepted. These views stimulated a most interesting discussion, in which many members of the Association took part.

There followed a discussion on the correlation of the Karagwe-Ankolean, Kavirondian, and Nyanzian formations of East and Central Africa, which again elicited much interesting information from many speakers. It was finally agreed that on the International Map these three formations should be shown by the same colour, but with different symbols. The correlation of the Akwapimian, Birrimian and Buem formations was vigorously discussed by West African geologists, and it was finally agreed that the legend should show the upward succession long adopted by the Gold Coast Geological Survey, namely, Birrimian, Tarkwaian, Akwapimian, but with a note that certain French geologists would place the Akwapimian much lower. The Buem was to be shown as Upper Pre-Cambrian, but with the reservation that it might be Cambrian.

Following a discussion on the age and correlation of the Upper Kundulungu and the Waterberg-Matsap, it was agreed that, on the map, these formations should be represented by one colour, and that in the legend the age should be left open, with the observation that the ages suggested by various geologists ranged from pre-Silurian to Devonian and even Carboniferous.

The value of African tillites for correlation purposes was discussed, as was also the importance of *Stromatolites* and comparable organisms in determining the age and relations of the older formations. It was at length agreed that owing to the lack of knowledge of the structure of these algal forms, they should be the subject of study by specialists; and on the motion of M. A. Jamotte, it was resolved that the International Palæontological Union should be invited to undertake a special study of them.

An extra meeting was devoted wholly to the problem of rift valleys, and following papers by Prof. R. M. Shackleton, Dr. R. B. McConnell and Mr. A. M. Quennell, a valuable and interesting discussion took place, in which many members participated.

A long discussion was devoted to the terminology of the African Pleistocene, and it was finally agreed to recommend the adoption of the resolution on this question by the African Pre-History Conference held at Nairobi in January 1947. A resolution was also passed recommending the formation of a sub-commission to study the distribution and correlation of the Kalahari Sands.

The question of the distribution, ages and origin of the African carbonatites also gave rise to a useful discussion.

Finally, during the last meeting of the Association, thirty-three personal contributions on the geology of the various territories of Northern, Central, Eastern and Southern Africa were noted, and certain of them briefly discussed.

It may be of interest to add that at a Specialist Geological Conference arranged in September by the British Commonwealth Scientific Organisation, in consequence of the presence in London of the delegates to the International Geological Congress, a discussion took place on the question of the formation of regional bureaux for the study of long-term fundamental research on African geological problems on a regional as distinct from a territorial basis.

This session of the Association of African Geological Surveys not only enabled many old personal contacts among African geologists to be renewed, but also led to many new ones; and the papers and discussions were of great interest and value not only because of the new observations revealed by them, but also on account of the stimulus they gave to international co-operation in the realms of geology and to a regional approach to many fundamental problems.

The Association recorded its appreciation of the invaluable services of its secretary, M. Blondel, not only in the successful organisation of the session, but also in co-ordinating the activities of the Association during the interval between the sessions of the Congress.

POWER SUPPLY AND THE ELECTRICAL ENGINEER

THE title "Means and Ends" given to the presidential address of Mr. T. J. N. Haldane to the Institution of Electrical Engineers on October 7 expressed at once the twofold character and the unity of his subject. An eloquent reaffirmation of the faith of the engineer in the ultimate value of his calling was made by Mr. Haldane in the second part of an address which in the factual sphere concerned itself with the position of electricity power supply in Great Britain and Western Europe.

Pointing out that as early as the beginning of the seventeenth century Francis Bacon had indicated that man's mental and material progress are inseparably linked with one another, Mr. Haldane said, "At present it is all too painfully obvious that for most of the world we are very far from having

achieved even that modest level of material prosperity such as would provide reasonable conditions for widespread spiritual development, which must, I believe, be regarded as our ultimate objective. So there remains a vast task for the scientist and engineer, whose work should receive whole-hearted approval, provided the raising of standards of life is regarded as a means rather than an end in itself." It was against this philosophic background that Mr. Haldane reviewed the position of electricity supply in Great Britain and in Western Europe.

Referring first to the nationalization of this industry in Britain, and remarking that we might well be proud of the way in which the change to public ownership had been accepted, Mr. Haldane expressed satisfaction at the new British Electricity Authority's keen awareness of the special problems resulting from the unification of this great undertaking. The twenty years of successful operation of the Central Electricity Board engendered confidence in the future of the new Authority.

Mr. Haldane first gave a brief review of the broad economic position, in which he referred to the importance to the electrical export trade of co-operation of the British Electricity Authority with manufacturers so as to ensure that plant developed for home use should also be suitable and competitive for export, and he also mentioned the not inconsiderable part played by the independent consulting engineer in fostering British trade abroad. He then gave detailed consideration to power resources, drawing a clear distinction between the requirements for power and requirements for energy. Mr. Haldane commented on the important contribution which could be made by water-power schemes towards the meeting of peak loads. Any given water-power scheme will be limited to a certain average annual output of kilowatt-hours; but it is possible to install a large amount of plant and make a correspondingly large contribution to the peak-load problem at the expense of a reduced annual load factor. One of the existing hydro-electric schemes, the Galloway development, was designed for an annual load factor of about 20 per cent; and for the new Sloy station on Loch Lomond the designed load factor was only 10 per cent. Tidal schemes and large-scale wind-generation, because of the intermittent character of their supplies, could make little contribution towards meeting peak loads but could add appreciably to the total output of energy. "Intermediate between the two extremes of pure kilowatts and pure kilowatt-hours," he said, "comes the gas-turbine, burning oil, whose importance is mainly as regards kilowatts, with a contribution to kilowatt-hours limited by economic considerations. Gas-turbines permit the cheap provision of kilowatts, but, until coal can be used in place of oil, cannot be justified for load factors above about 10 per cent or 15 per cent. No doubt, nuclear fission, if and when used for power production, will also have special circumstances attached to its use, such as, perhaps, development only on a large scale in remote regions at a very high load factor. Our main source of both kilowatts and kilowatt-hours must, however, continue to be coal, whose use we can hope to improve by a further increase in operational economy and by limiting, where possible, transport of this fuel particularly by rail." Referring further to the gas-turbine, Mr. Haldane stated that several large gas-turbine sets of the order of 15,000-kW. capacity were at present under construction for use as peak-load plant. It might seem surprising that active consideration was being given to the possible large-scale use of wind power. "The renewed interest in the subject is due mainly to three factors: the existence of extensive grid systems into which intermittent supplies of energy, wherever produced, can be fed; the increased knowledge of aerodynamics; and the shortage of coal." The western shores of the British Isles are well suited to the large-scale development of wind power, and this source of energy deserves more attention than it has received in the past.

Referring to the siting of generating stations, Mr. Haldane said that there were, broadly speaking, three choices: at the load centre, at or near the pithead, or on an estuary site to which coal could be delivered by sea. Estuary sites far removed from the load centre were unlikely to compare favourably with generation at or near the pithead. An economic comparison relating to the London area showed that, once all the available estuary sites had been used, it would be advantageous to place the bulk of future generating stations near the coalfields, with high-voltage transmission to the load centre. Peak-load plant at the load centre might well consist largely of gas-turbines.

Second only in importance to the actual generation of the required amount of electric power came the provision of adequate transmission and interconnexion facilities. This function had been served in Great Britain up to the present by the 132-kV. grid; but consideration had been given to the desirability of providing an additional national busbar operating at a higher voltage. We were about to experiment with the use of 275 kV., which was regarded as adequate for the distances over which we had to transmit and was, incidentally, considered to be the highest voltage for which underground cables could be built at the present time. The highest voltage A.C. system in Europe was at present under construction in Sweden, where a large block of power would be transmitted a distance of about 600 miles at 380 kV. "It may well be desirable," said Mr. Haldane, "to proceed as soon as possible with the construction of such a very high voltage system superimposed on the existing 132-kV. grid."

Turning to the power problems of Western Europe, which are even more acute than those of Great Britain, Mr. Haldane showed on a map the distribution of energy resources. It had long been hoped, he said, that some day all the Western European countries would be interconnected so as to make better use of the available resources. "Technically it should be possible to have high capacity interconnexion extending eventually from Scandinavia in the north to France in the south, with further interconnexion to Austria, Switzerland and Italy. Economically it seems likely that this would be highly beneficial. In fact, few measures could be expected to be more beneficial to European economic life than such integration of power resources, meeting as it would one of the most urgent of Europe's problems and helping towards unification." In this connexion, the question arose of the desirability of a connexion between the British system and that of the Continent. Technically, an interconnecting link between, say, London and Paris by high-voltage cable across the Channel appeared practicable. The question was whether the expenditure would be justified by saving in plant and interchange of energy.

The second part of Mr. Haldane's address was concerned with the philosophical implications of the

activities of the engineer and the reaction of present-day conditions on his outlook. "As engineers concerned with applied science," said Mr. Haldane, "we occupy a position intermediate between that of pure science and that of the branches of knowledge concerned with human affairs. We are very definitely concerned both with the advancement of scientific knowledge and with the problem of how this knowledge can best be applied to meet human needs. The latter function makes it particularly important that the general educational background of engineering training should be as wide as possible and should not exclude those branches of knowledge generally known as the humanities.

"The present difficulties due to the huge content of knowledge and consequent tendency towards excessive specialization have led to the disappearance at an early stage in education of any general study of religion or philosophy, so that at the age when young people are becoming able to think on such subjects the great majority proceed to concentrate on mastering the means of life and remain indifferent to, and almost oblivious of, its ends.

"Future generations may well be amazed at our acceptance of such a state of affairs, the existence of which I feel to be one of the strongest arguments in favour of the higher education of engineers being centred in the universities rather than in mono-technic colleges. Although even in the best of our universities there may be too much concentration on means and too little thought about ends, the engineering undergraduate does at least get and give the immense advantage of mixing with those who are studying totally different branches of knowledge. The whole atmosphere of a university engineering education can be influenced by contacts with the other faculties, including the humanities, and consequently study can be on a much broader basis than is possible in colleges or institutions dealing with one subject or group of subjects."

In summing up, Mr. Haldane remarked, "In providing the conditions in which the things of the spirit can come to full fruition we undertake a vital as well as a noble task in which we can have the utmost pride. But let us fully understand the nature of our task, and let us spend more time than we now do in considering the ends to which our work is directed."

MODERN DEVELOPMENTS IN FORESTRY

IN *Forestry Abstracts* (Commonwealth Forestry Bureau, vol. 10, No. 1 Abstracts (1)—(849), September 1948, Commonwealth Forestry Bureau, Oxford), Mr. J. J. MacGregor, of the Imperial Forestry Institute, Oxford, has an interesting paper on "Some Improved Techniques in Nurseries and on Planting Sites". There are many influences, he says, compelling foresters all over the world to revise time-worn practices. These influences are part of the general economic environment in which rising wages and relative shortages of labour are, perhaps, most significant. They have directly stimulated the search for more economic methods, machines and techniques. In a general way, current and recent developments have proceeded along the two main lines of 'rationalization' and the application of new techniques to specific operations. The latter, which includes the adoption of mechanization, improved processes with new tools and new treatments, forms the basis of the article.

In using the term 'rationalization' the author means it to be applied to the administration of staff, the training of subordinate workers, housing and amenities, the execution and close inspection of all work, and the provision of tools; on this last point of tools one might add that, until recently in ordinary forest work, they were few, simple and no different from those in existence during what may be called the pre-mechanized times. In the modern study of these methods Sweden has given the lead and has been in the position, during the past ten years, when so many were otherwise engaged, to make considerable progress; and mention must be made of Swedish reorganisation of piece-work rates, which require to be both flexible and easily understood. Both in North America and in Germany forestry experts have been making similar studies. One form of 'rationalization' has been the suggested centralization of forest nurseries, since it is held, and rightly so, that the efficient raising of large stocks requires highly skilled and experienced supervision. Whether, however, the small nursery on the private estate should be regarded as obsolete is a matter which is open to considerable argument. The big battalions are by no means the safest in a matter of this kind, for many reasons.

On the side of technical mechanical developments, North America takes the lead. In agriculture, the application of labour-saving devices has gone a long way, and a few have been adapted for forestry purposes. But it is felt that special investigations, which are indeed being carried out by those conversant with forest nursery and other wider forestry problems, will have a greater chance of giving the forester new mechanical implements suitable to his particular type of work. The article also deals with the transfer of planting stock (storage and packing), preparation of sites, stump removal, plough and cultivators (the Forestry Commission has had a considerable success based on experiments with heavy ploughs), sowing and planting, planting methods and machines.

LABORATORY GLASSWARE PRODUCTION

THE expression 'E-MIL' may not be quite so well known as some others which have become quite commonplace; but it is likely to become a mark of quality standard in future. Messrs. H. J. Elliott, Ltd., Treforest Trading Estate, Nr. Pontypridd, Glam., whose trade mark it is, already enjoy a reputation for high-quality glassware for quantitative work; but they laudably seek to enhance that reputation by aiming at still higher standards and by offering unconditional guarantees concerning their products, as well as improvements in the character and packaging of the articles.

In the first place, their volumetric glassware will be designated 'E-Mil Green Line' in the case of that which complies with National Physical Laboratory grade *A* specifications, and 'E-Mil Gold Line' for that of the grade *B* standard, the graduations of these varieties being filled respectively with insoluble green and yellow enamels. The pigments appear to be

somewhat fluorescent, for they are easily visible in poor lighting, even with coloured solutions. Furthermore, the markings, which are fused into the glass, seem to be irremovable except by such chemicals as those which corrode the glass itself.

Stoppers in graduated flasks and cylinders have always tended to be troublesome owing to a propensity for 'seizing'. The new 'E-MIL' stopper is a valuable accessory. Accurately moulded from an almost inert plastic, it provides a gas-tight and liquid-tight closure to an orifice of British Standards Institution specification taper (although it is not of B.S.I. specification dimensions), but does not bind or seize up irremovably. It is understood that patent protection is being sought for this attractive article.

Nor is this all, for the firm has introduced another innovation. It feels that the old style of crating a number of items amid masses of wood-wool, straw, sawdust and the like is not good enough for precision equipment; the packing material might be dusty and soil the articles, even if paper wrappings are used in addition, and by no means does it ensure safe transport unless an expert is employed to pack and another to unpack. Even with this system, overhead costs can easily be inflated by 'on-the-floor' losses in transferring the goods to storage bins, then to shelves and counters and finally with, or sometimes without, further packing, to the possession of the ultimate user. The firm feels that it can reduce these losses by sealing each article into its own specially fitting carton, which will be unreturnable and will doubtless be retained by many a technician as it provides a convenient pigeon-hole for the safe storage of the article in his locker. It is obvious that the extra expenses of this carton packing will be offset by dispensing with crates, etc., and with the trouble of their recovery as returned empties, not forgetting the overhead expenses and office work associated with the latter.

This programme could not be so courageously planned by the management had it not the whole-hearted loyalty of its employees, to whom it gives very strong incentives to produce not only quantity but also quality in whatever they are making. The result is not a mere 'master and man' condition but the development of what may be described as a happy family, some members of which are miners who can no longer follow their former employment because of the dreaded silicosis, some are ex-Service men whose injuries limit their capabilities in the way of earning a living, and others are women and young people with a flair for delicate manipulation. It is good to see them working with a will, and everywhere there is evidence—sometimes resonant—of happy and contented folk.

R. Sutcliffe

EDUCATION IN HAITI

THE U.S. Office of Education has undertaken the preparation of a series of basic studies in education in a number of Central and South American countries. This series of studies is part of a programme to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. The project, part of a government-wide programme of cultural co-operation under the auspices of the U.S. Department of State, was begun in the autumn of 1943. It involves travel by Office of Education specialists in the various countries in order to gather information at first hand on their educational systems and to prepare reports for publication.

"Education in Haiti" (Washington, D.C.: Gov. Printing Office. 25 cents) is based on data collected by Prof. Mercer Cook during a twenty-two months stay in which, as supervisor of an English-teaching project which was initially sponsored by the U.S. Office of Education, he was able to make use of authoritative sources of information.

The total area of the Republic of Haiti is about 10,700 square miles, more than two-thirds of which is covered by highlands. This complicates the construction of roads and renders many villages practically inaccessible to commerce and to education. The high rate of illiteracy—estimated at about 92 per cent by some observers—should thus be attributed in some part to topography. No scientific attempt has ever been made to count the total number of Haitians, but an estimate made in 1937 puts the total population at about three millions. Of these, nine-tenths live in rural areas and, as in other Latin-American countries, the fundamental educational problem is that of the rural school. Already, in the words of a contemporary Haitian novelist, erosion has "bled the earth to the bone", and the problem of this agricultural country is to try to intensify its agricultural effort by educating the peasant in modern methods of cultivation and soil conservation. Until this problem of rural education is satisfactorily solved, Haiti seems destined to remain a desperately poor country. The converse is equally true. Progress has been made in recent years; but the deplorable facts remain that four out of five peasant children never attend school; that teachers' salaries are inadequate; that many school buildings are hopelessly unsatisfactory; that equipment and textbooks are often unobtainable; that malaria, yaws, syphilis, tuberculosis and hookworm have undermined the health of the Haitian; that, as one Haitian physician states, "the diet of the Haitian peasant has not changed since slavery days"; and that education has been tied up too closely with politics.

The language problem is also a considerable source of difficulty to Haitian educationists. The official language of the republic is French, while "not one peasant out of a 100 can even guess what is being said in that language"; all Haitians understand Creole and most of them speak it. From Prof. Cook's observations it is apparent that poverty, ill-health, politics and linguistics are the basic ills that beset the Haitian school teacher, and the greatest of these is poverty. "On less than the average income of a first-class American university, the Haitians must provide and maintain elementary, secondary, professional, rural and vocational schools for a population of approximately three millions."

Despite these and other obstacles, however, the Haitians, through their own efforts and with some aid from foreigners, principally French and North American, have, during the last twenty years, progressed along the road to enlightenment. Their schools are no longer entirely literary or classical, teachers are better trained and somewhat better paid; printed regulations are less frequently disregarded. Yet, as Prof. Cook has shown, much remains to be done, and his report will prove invaluable in concentrating attention on the state of education in Haiti.

T. H. Hawkins

FORTHCOMING EVENT

Monday, December 20

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. E. G. R. Taylor and Prof. W. M. Smart, F.R.S.: "The Navigator's Story".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (non-medical)—The Director of the Pathological Laboratory, General Hospital, Middlesbrough (December 25).

PRINCIPAL SCIENTIFIC OFFICER (with a First or Second Class Honours Degree in Mathematics or an equivalent qualification, and ability to apply mathematics to tidal movements, etc.) in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2336 (December 30).

PRINCIPAL SCIENTIFIC OFFICERS in the Headquarters Office in London of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2335 (December 30).

HORTICULTURAL OFFICER in Grade II of the National Agricultural Advisory Service—The Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N.W.1, endorsed N.A.A.S. (December 31).

SENIOR RESEARCH OFFICER in the Organic Chemistry Section of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (December 31).

PHYSICISTS and MATHEMATICIANS (for unestablished posts in the Experimental Officer class) in Ministry of Supply research and development establishments in Southern England and South Midlands, for duties concerned with aerodynamics, armaments, ballistics, crystallography, fuels, heat, jet propulsion, radio and radar, and X-rays—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.398/48A (December 31).

SENIOR SCIENTIFIC OFFICER (Ref. A.403/48A) to lead a group of physicists and engineers studying effect of tropical conditions on Service materials and equipment, and a SCIENTIFIC OFFICER (Ref. F.429/48A) to work in analytical or biochemical investigations into deterioration of equipment under tropical conditions, at the Tropical Testing Establishment, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (January 3).

DEMONSTRATOR IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (January 8).

READERSHIP IN DEMOGRAPHY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 20).

POSTGRADUATE STUDENTSHIPS in preparation for research into stored products entomology in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (April 30).

CHEMISTS IN THE JOINT DEPARTMENT OF CHEMISTRY, Federation of Malaya—The Director of Recruitment, Colonial Service, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1.

RESEARCH ASSISTANT in the field of Organic Chemistry—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, Royal Technical College, Glasgow.

PHYSICAL CHEMISTS as Scientific Officers at a Ministry of Supply research and development establishment near London for duties in (*a*) high temperature refractories, (*b*) crystallography and practical microscopy, (*c*) spectrography and (*d*) plant development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1025/48A.

CHEMICAL ENGINEER IN THE DIVISION OF ATOMIC ENERGY (Production), Risley, to assist in the design and operation of a prototype plant with a view to helping in the design and construction of a large production plant—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT EDITOR of *Science Abstracts*—The Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Building Studies. Bulletin No. 1: Clay Building Bricks, their Manufacture, Properties and Testing; with Notes on the Efficiency of Brickwork. By B. Butterworth. Pp. iv+24+9 plates. (London: H.M. Stationery Office, 1948.) 1*s.* net. [98

Progress in Leather Science, 1920–1945. Issued in commemoration of the Twenty-fifth Anniversary of the formation of the British Leather Manufacturers' Research Association. Vol. 1. Pp. viii+220. Vol. 2. Pp. xi+221–486. Vol. 3. Pp. xii+487–705. (London: British Leather Manufacturers' Research Association, 1946–1948.) [118

Ovaltine Research Laboratories. Annual Report, 1947. Pp. 8. (London: A. Wander, Ltd., 1948.) [118

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 830, Vol. 241: The Growth-Inhibitory and Carcinogenic Properties of 4-Aminostilbene and Derivatives. By A. Haddow, R. J. C. Harris, G. A. R. Kon and Edna M. F. Roe. Pp. 147–196. 15*s.* No. 831, Vol. 241: The Sensitiveness of Explosives. By J. L. Copp, S. E. Napier, T. Nash, W. J. Powell, H. Skelly, A. R. Ubbelohde and P. Woodward. Pp. 197–296. 30*s.* No. 832, Vol. 241: The First Spectrum of Copper (Cu 1). By A. G. Shenstone. Pp. 297–322. 6*s.* (London: Cambridge University Press, 1948.) [168

A Descriptive Guide to the Libraries of the University of Leeds. By Dr. Richard Offor. Pp. 134+6 plates. (Leeds: Brotherton Library, The University, 1947.) 6*s.* 6*d.* [168

The British Council. Report for 1947–1948. Pp. 88. (London: British Council, 1948.) [168

Physical Society. Reports on Progress in Physics. Vol. 11 (1946–47). Pp. iv+462+11 plates. (London: Physical Society, 1948.) 42*s.* net; to Fellows, 25*s.* net. [168

Lambeth Conference 1948: The Encyclical Letter from the Bishops, together with Resolutions and Reports. Pp. v+53+iv+120. (London: S.P.C.K., 1948.) 5*s.* [178

National Building Studies. Special Report No. 1: Structural Requirements for Houses. By Dr. F. G. Thomas. Pp. iv+9+11 plates. (London: H.M. Stationery Office, 1948.) 9*d.* net. [178

Diamond Tool Patents, 2: Diamond Abrasive Wheels. Edited by P. Grodzinski. Pp. 52. (London: Industrial Diamond Information Bureau, 1948.) 10*s.* [178

Report of a Conference on Strength of Solids held at the H. H. Wills Physical Laboratory, University of Bristol, on 7–9 July 1947. Pp. iv+162. (London: Physical Society, 1948.) 25*s.* [178

National Building Studies. Special Report No. 2: Plumbing in America; a Report on a Visit to U.S.A. and Canada on Plumbing. By F. L. Barrow. Pp. iv+24. (London: H.M. Stationery Office, 1948.) 6*d.* net. [188

Imperial Agricultural Bureaux. Joint Publication No. 12: Phenothiazine in Veterinary Medicine; a Review of the Literature of 1942–46, by J. Tweedale Edwards; Bibliography of Phenothiazine as an Anthelmintic, 1942–46, by the Imperial Bureau of Agricultural Parasitology. Pp. 36. (Weybridge: Imperial Bureau of Animal Health; St. Albans: Imperial Bureau of Agricultural Parasitology, 1947.) 4*s.* [198

Economic Thought and Industrial Policy: an Inaugural Lecture delivered at University College, London, on March 4th, 1948. By Prof. G. C. Allen. Pp. ii+18. (London: H. K. Lewis and Co., Ltd., 1948.) 2*s.* 6*d.* net. [198

Other Countries

Bernice P. Bishop Museum. Bulletin 193: Specialized Studies in Polynesian Anthropology. By Katharine Luomala, Felix M. Keesing, Marie Keesing, Ernest Beaglehole and E. G. Burrows. Pp. iv+88. Bulletin 194: Report of the Director for 1947. By Peter H. Buck (Te Rangi Hiroa). Pp. 40. (Honolulu: Bernice P. Bishop Museum, 1947–1948.) [38

Western Australia Geological Survey. Bulletin No. 101: The Mining Groups of the Yilgarn Goldfield north of the Great Eastern Railway. By R. S. Matheson; with Three Appendices by Dr. K. R. Miles. Pp. 242+ix. (Perth: Government Printer, 1947.) [48

Smithsonian Institution: Bureau of American Ethnology. Bulletin 143: Handbook of South American Indians. Edited by Julian H. Steward. Vol. 4: The Circum-Caribbean Tribes. Pp. xx+609+9e plates. (Washington, D.C.: Government Printing Office, 1948.) [98

Smithsonian Institution: United States National Museum. Bulletin 195: Life Histories of North American Nuthatches, Wrens, Thrashers and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. xi+475+90 plates. (Washington, D.C.: Government Printing Office, 1948.) 1.75 dollars. [98

Conseil International des Unions scientifiques. Sixième rapport de la Commission pour l'étude des Relations entre les phénomènes solaires et terrestres. Pp. 215. (Orléans: Imprimerie Nouvelle, 1948.) [98

Smithsonian Institution: Institute of Social Anthropology. Publication No. 8: Sierra Popoluca Speech. By Mary L. Foster and George M. Foster. Pp. iii+45. (Washington, D.C.: Government Printing Office, 1948.) 40 cents. [98

Twenty-eighth Annual Report of the Research Council of Alberta, 1947. (Report No. 51.) Pp. 28. (Edmonton: King's Printer, 1948.) [118

South African Institute for Medical Research. Annual Report for the Year 1947. Pp. 67. (Johannesburg: South African Institute for Medical Research, 1948.) [118

Chicago Natural History Museum. Report of the Director to the Board of Trustees for the Year 1947. Pp. 144. (Chicago: Chicago Natural History Museum, 1948.) 1 dollar. [128

Illinois Natural History Survey. Bulletin, Vol. 24, Article 2: The Leafhoppers, or Cicadellidae, of Illinois (Eurymelinae-Balcluthinae). By D. M. DeLong. Pp. 91–376. (Urbana: Illinois Natural History Survey, 1948.) [168

Handbook of Scientific and Technical Societies and Institutions of the United States and Canada. (Bulletin of the National Research Council, No. 115.) Fifth edition. Pp. 371. (Washington, D.C.: National Academy of Sciences, 1948.) 5 dollars. [178

Smithsonian Miscellaneous Collections. Vol. 108: Compendio y descripción de las Indias occidentales. Por Antonio Vazquez de Espinosa. Transcrito del manuscrito original por Charles Upson Clark. (Publication 3898.) Pp. xii+801. (Washington, D.C.: Smithsonian Institution, 1948.) [198

Catalogues

Maps and Atlases of the British Isles from the 16th to 19th Century. (Catalogue No. 692.) Pp. 78. (London: Francis Edwards, Ltd., 1948.)

The Tilgate Story. Pp. 20. (London: F. W. Berk and Co., Ltd., 1948.)